Metal Progress

October, 1942 Vol. 42, No. 4

General Section

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Section on Non-Ferrous Metals

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Section on Metal Working

Section on Cleaning and Finishing

American Society for Metals

PRESIDENTS

ALBERT E. WHITE	1921	FREDERICK G. HUGHES	1928	ROBERT S. ARCHER	1936
FRANK P. GILLIGAN	1922	ZAY JEFFRIES	1929	EDGAR C. BAIN	1937
†TILLMAN D. LYNCH	1923	ROBERT G. GUTHRIE	1930	GEORGE B. WATERHOUSE	1938
†GEORGE K. BURGESS	1924	J. MITCHELL WATSON	1931	WILLIAM P. WOODSIDE	1939
†WILLIAM S. BIDLE	1925	ALEXANDER H. d'ARCAMBAL	1932	JAMES P. GILL	1940
†ROBERT M. BIRD	1926	WILLIAM B. COLEMAN	1933	OSCAR E. HARDER	1941
J. FLETCHER HARPER	1927	WILLIAM H. PHILLIPS	1934	BRADLEY STOUGHTON	1942
		BENJAMIN F. SHEPHERD	1935		

SECRETARY

WILLIAM H. EISENMAN 1920–

FOUNDER MEMBERS

†THEODORE E. BARKER	WILLIAM P. WOODSIDE
†ARTHUR G. HENRY	ALBERT E. WHITE

HONORARY MEMBERS

†CHARLES F. BRUSH	†SIR ROBERT HADFIELD	ZAY JEFFRIES
†EDWARD DE MILLE CAMPBELL	†ELWOOD HAYNES	†JOHN A. MATHEWS
†HENRY LE CHATELIER	KOTARO HONDA	†ALBERT SAUVEUR
†THOMAS ALVA EDISON	†HENRY MARION HOWE	†CHARLES M. SCHWAB
†ELBERT H. GARY	CHARLES F. KETTERING	WILLIS R. WHITNEY

SAUVEUR ACHIEVEMENT MEDALISTS

†ALBERT SAUVEUR	1934	WILLIAM R. CHAPIN	1936	A. W. MACHLET	1940
ZAY JEFFRIES	1935	HARRY W. McQUAID	1938	ALBERT L. MARSH	1941
		†STANLEY P. ROCKWELL	1939		

HENRY MARION HOWE MEDALISTS

EMANUEL J. JANITZKY	1922	KARL HEINDLHOFER	1931	A. G. H. ANDERSEN	1937
FRANCIS F. LUCAS	1924	FRANCIS M. WALTERS	1932	ERIC R. JETTE	1937
HORACE H. LESTER	1925	CYRIL WELLS	1932	JOSEPH WINLOCK	1938
†FREDERICK C. LANGENBERG	1926	MAXWELL GENSAMER	1932	RALPH W. E. LEITER	1938
WESLEY P. SYKES	1927	JOHN F. ECKEL	1932	CHARLES S. BARRETT	1939
OSCAR E. HARDER	1928	JOSEPH V. EMMONS	1933	GERHARD ANSEL	1939
RALPH L. DOWDELL	1928	JOHN CHIPMAN	1934	ROBERT F. MEHL	1939
†CARL R. WOHRMAN	1929	TRYGVE D. YENSEN	1935	MARCUS A. GROSSMANN	1941
HERBERT J. FRENCH	1930	NICHOLAS A. ZIEGLER	1935	MORRIS ASIMOW	1941
EDGAR C. BAIN	1931			S. F. URBAN	1941

PUBLICATION COMMITTEE CHAIRMEN

†HERBERT M. BOYLSTON	1920–29	AUGUSTUS B. KINZEL	1932–33	WESLEY P. SYKES	1934–36
WILLIAM B. COLEMAN	1929–30	GERALD R. BROPHY	1933–34	A. ALLAN BATES	1936–38
VICTOR O. HOMERBERG	1930–32			LOUIS W. KEMPF	1938–

METALS HANDBOOK COMMITTEE CHAIRMEN

Standards Committee		*Recommended Practice Committee*		*Metals Handbook Committee*	
†TILLMAN D. LYNCH	1920–22	J. FLETCHER HARPER	1923–27	CHARLES H. HERTY, JR.	1934–36
†ROBERT M. BIRD	1922–23	†WILLIAM J. MERTEN	1927–31	JAMES P. GILL	1936–37
		L. B. CASE	1931–33	RALPH L. DOWDELL	1937–39
		CHARLES H. HERTY, JR.	1933–34	ROBERT S. ARCHER	1939–

LOCATION OF CONVENTION AND EXPOSITION

1920 — PHILADELPHIA	1925 — CLEVELAND	1931 — BOSTON	1937 — ATLANTIC CITY
1921 — INDIANAPOLIS	1926 — CHICAGO	1932 — BUFFALO	1938 — DETROIT
1922 — DETROIT	1927 — DETROIT	1933 — DETROIT	1939 — CHICAGO
1923 — PITTSBURGH	1928 — PHILADELPHIA	1934 — NEW YORK	1940 — CLEVELAND
1924 — BOSTON	1929 — CLEVELAND	1935 — CHICAGO	1941 — PHILADELPHIA
	1930 — CHICAGO	1936 — CLEVELAND	1942 — CLEVELAND

CAMPBELL MEMORIAL LECTURERS

WILLIAM M. GUERTLER	1926	CHARLES H. HERTY, JR.	1931	WESLEY P. SYKES	1937
ZAY JEFFRIES	1927	EDGAR C. BAIN	1932	ALFRED L. BOEGEHOLD	1938
W. H. HATFIELD	1928	HERBERT J. FRENCH	1933	EDMUND S. DAVENPORT	1939
†ALBERT SAUVEUR	1929	VSEVOLOD N. KRIVOBOK	1934	SAMUEL L. HOYT	1940
MARCUS A. GROSSMANN	1930	HARRY W. McQUAID	1935	ROBERT F. MEHL	1941
		JAMES P. GILL	1936	JOHN CHIPMAN	1942

† Deceased

CONSOLIDATED PROGRAM

National Metal Congress

War Production Edition

AMERICAN SOCIETY FOR METALS AMERICAN WELDING SOCIETY
AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS
THE WIRE ASSOCIATION

Monday, Oct. 12, 1942

9:00 A.M. American Foundrymen's Association (A.F.A) Cupola Research Steering Committee; Hotel Statler

9:30 A.M. American Society for Metals Heat Treatment Session; Hotel Statler (page 500)

9:30 A.M. Steel Properties Session; Hotel Statler (page 500)

9:30 A.M. Testing Session; Hotel Statler (page 500)

9:30 A.M. American Welding Society (A.W.S.) Presentation of Medals and Prizes; Hotel Cleveland (page 508)

10:15 A.M. A.W.S. Session on Training of Welding Operators and Qualifications; Hotel Cleveland (page 508)

10:30 A.M. Wire Association (W.A.) Directors Meeting; Hotel Carter (page 511)

11:30 A.M. Victory Hour, Design for Winning; Hotel Statler

12:00 M. National Metal Exposition opens; Public Auditorium (page 514)

12:00 M. W.A. Program Committee Luncheon; Hotel Carter (page 511)

2:00 P.M. War Production Meeting on NE Steels; Public Auditorium (page 502)

2:00 P.M. War Production Meeting on Aluminum; Public Auditorium (page 502)

2:00 P.M. American Institute of Mining and Metallurgical Engineers (A.I.M.E.) (Institute of Metals Division) Session on Copper-Base Alloys; Hotel Statler (page 510)

2:00 P.M. A.I.M.E. (Iron and Steel Division) Session on Magnetite Reduction, Chromizing, Weldability; Hotel Statler (page 510)

2:00 P.M. A.W.S. Session on Fatigue and Impact; Hotel Cleveland (page 508)

2:00 P.M. A.W.S. War Production Session; Hotel Cleveland (page 508)

2:30 P.M. W.A. Technical Session; Hotel Carter (page 511)

4:00 P.M. War Production Meeting on Employee Training; Public Auditorium (page 502)

5:00 P.M. Lecture Course, Toolsteels; Public Auditorium (page 500)

7:30 P.M. A.W.S. Motion Picture Films; Hotel Cleveland (page 508)

7:30 P.M. A.W.S. Industrial Research Dinner; Hotel Cleveland (page 508)

8:00 P.M. War Production Meeting on NE Steels; Public Auditorium (page 503)

8:00 P.M. War Production Meeting on Magnesium; Public Auditorium (page 503)

8:00 P.M. War Production Meeting on Tool Salvage; Public Auditorium (page 503)

10:30 P.M. National Metal Exposition closes

Tuesday, Oct. 13, 1942

9:30 A.M. Session on Hardenability of Steel; Hotel Statler (page 500)

9:30 A.M. Molybdenum Steels Session; Hotel Statler (page 500)

9:30 A.M. Research Methods Session; Hotel Statler (page 500)

9:30 A.M. A.I.M.E. (Institute of Metals Division) Symposium on Rare and Precious Metals; Hotel Statler (page 510)

9:30 A.M. A.W.S. Session on Weldability of Steel; Hotel Cleveland (page 508)

9:30 A.M. A.W.S. Session on Aircraft Welding (Fuselage); Hotel Cleveland (page 508)

9:30 A.M. W.A. Technical Session (page 511)

10:00 A.M. A.I.M.E. (Iron and Steel Division) Session on Tensile Properties and Hardenability; Hotel Statler (page 510)

10:00 A.M. A.F.A. Committee on High Temperature Properties of Cast Iron; Hotel Statler

10:00 A.M. A.F.A. Core Test Meeting and Luncheon; Hotel Statler

11:30 A.M. Victory Hour, Design for Winning; Hotel Statler

12:00 M. National Metal Exposition opens; Public Auditorium (page 514)

12:00 M. Canadian Luncheon; Hotel Statler

12:00 M. Women in Metallurgy Luncheon; Women's City Club

12:00 M. A.I.M.E. (Iron and Steel Division) Executive Committee Luncheon; Hotel Statler (page 510)

12:30 P.M. A.F.A. Gray Iron Division Advisory Committee Luncheon

1:00 P.M. W.A. Annual Luncheon; Hotel Carter (page 511)

2:00 P.M. War Production Meeting on Toolsteels; Public Auditorium (page 503)

2:00 P.M. A.I.M.E. (Institute of Metals Division) Symposium on Rare and Precious Metals; Hotel Statler (page 510)

2:00 P.M. A.I.M.E. (Iron and Steel Division) Session on Openhearth Steel; Hotel Statler (page 510)

2:00 P.M. A.W.S. Session on Weldability of Steel; Hotel Cleveland (page 508)

2:00 P.M. A.W.S. Session on Aircraft Welding (Sheet); Hotel Cleveland (page 508)

2:00 P.M. A.W.S. Gas Cutting Session; Hotel Cleveland (page 508)

4:00 P.M. War Production Meeting on Magnaflux; Public Auditorium (page 503)

Tuesday, Oct. 13, 1942 (Continued)

4:30 P.M. W.A. Annual Meeting; Hotel Carter

5:00 P.M. Lecture Course, Toolsteels; Public Auditorium (page 500)

5:00 P.M. A.F.A. Technical Correlation Committee Meeting and Dinner; Hotel Statler

7:00 P.M. A.I.M.E. (Iron and Steel and Institute of Metals Divisions) Annual Dinner; Hotel Statler (page 510)

7:30 P.M. A.W.S. Fundamental Research Conference; Hotel Cleveland (page 508)

8:00 P.M. War Production Meeting on Die Steels; Public Auditorium (page 504)

8:00 P.M. War Production Meeting on Radiography; Public Auditorium (page 504)

8:00 P.M. War Production Meeting on Metal Cutting; Public Auditorium (page 504)

10:30 P.M. National Metal Exposition closes

Wednesday, Oct. 14, 1942

7:30 A.M. Chapter Chairmen and WPAC Chairmen, Breakfast; Hotel Statler

8:00 A.M. Industrial Gas Breakfast; Hotel Statler

9:00 A.M. Annual Meeting and Campbell Memorial Lecture; Hotel Statler (page 501)

9:30 A.M. A.W.S. Resistance Welding Session; Hotel Cleveland (page 509)

9:30 A.M. A.W.S. Production Welding Session; Hotel Cleveland (page 509)

9:45 A.M. W.A. Technical Session; Hotel Carter (page 511)

10:00 A.M. A.F.A. Sand Research Committee; Hotel Statler

12:00 M. National Metal Exposition opens; Public Auditorium (page 514)

12:00 M. College Alumni Luncheons; Hotel Statler

12:00 M. A.I.M.E. (Institute of Metals Division) Executive Committee Luncheon; Hotel Statler (page 511)

12:00 M. International Acetylene Association Luncheon and Annual Business Meeting; Hotel Cleveland (page 509)

2:00 P.M. War Production Meeting on Openhearth Steel; Public Auditorium (page 505)

2:00 P.M. War Production Meeting on Steel Foundry; Public Auditorium (page 505)

2:00 P.M. A.I.M.E. (Institute of Metals Division) Session on Aluminum, Magnesium and Lead; Hotel Statler (page 511)

2:00 P.M. A.I.M.E. (Iron and Steel Division) Session on Physical Chemistry of Steel Making; Hotel Statler (page 511)

2:00 P.M. A.W.S. Resistance Welding Session; Hotel Cleveland (page 509)

2:00 P.M. A.W.S. Session on Welding and Cutting of Ordnance; Hotel Cleveland (page 509)

2:00 P.M. A.W.S. Shipbuilding Session; Hotel Cleveland (page 509)

2:00 P.M. W.A. Mordica Memorial Lecture; Hotel Carter (page 511)

2:00 P.M. A.F.A. Brass and Bronze Division Advisory Committee; Hotel Statler

4:00 P.M. War Production Meeting on Powdered Metals; Public Auditorium (page 505)

4:00 P.M. War Production Meeting on Special Additions to Steel; Public Auditorium (page 505)

5:00 P.M. Lecture Course, Toolsteels; Public Auditorium (page 500)

7:30 P.M. A.W.S. Section Officers' Dinner and Conference; Hotel Cleveland (page 509)

7:30 P.M. W.A. Annual Dinner and Stag Smoker; Hotel Carter (page 511)

8:00 P.M. War Production Meeting on Electric Furnace Steels; Public Auditorium (page 506)

8:00 P.M. War Production Meeting on Inspector Training; Public Auditorium (page 506)

10:30 P.M. National Metal Exposition closes

Thursday, Oct. 15, 1942

9:30 A.M. Session on Formation of Austenite; Hotel Statler (page 501)

9:30 A.M. Session on Strength of Metals; Hotel Statler (page 501)

9:30 A.M. Steel Making Session; Hotel Statler (see page 501)

9:30 A.M. A.W.S. Aircraft Welding Session; Hotel Cleveland (page 509)

9:30 A.M. A.W.S. Session on Non-Destructive Tests and Inspection; Hotel Cleveland (page 509)

9:45 A.M. W.A. Technical Session; Hotel Carter (page 511)

11:30 A.M. Victory Hour, Design for Winning; Hotel Statler

12:00 M. National Metal Exposition opens; Public Auditorium (page 514)

12:00 M. A.I.M.E. (Iron and Steel Division) Physical Chemistry of Steelmaking Committee Luncheon; Hotel Statler (page 511)

1:30 P.M. W.A. Plant Inspection of Electric Patenting (page 511)

2:00 P.M. War Production Meeting on Secondary Metals; Public Auditorium (page 506)

2:00 P.M. War Production Meeting on Production Heating; Public Auditorium (page 507)

2:00 P.M. A.W.S. Business Meeting; Hotel Cleveland (page 509)

3:00 P.M. A.W.S. Board of Directors' Meeting; Hotel Cleveland (page 509)

4:00 P.M. War Production Meeting on Metal Scrap; Public Auditorium (page 507)

5:00 P.M. Lecture Course, Toolsteels; Public Auditorium (page 500)

6:00 P.M. National Metal Exposition closes

7:00 P.M. Annual Dinner; Hotel Statler

Friday, Oct. 16, 1942

9:30 A.M. Toolsteels Session; Hotel Statler (page 501)

9:30 A.M. Session on Cold Work; Hotel Statler (page 501)

9:30 A.M. Session on Non-Ferrous Alloys; Hotel Statler (page 501)

11:30 A.M. Victory Hour, Design for Winning; Hotel Statler

12:00 M. National Metal Exposition opens; Public Auditorium (page 514)

2:00 P.M. War Production Meeting on Production Hardening; Public Auditorium (page 507)

2:00 P.M. War Production Meeting on Tin Alloys; Public Auditorium (page 507)

2:00 P.M. Lecture Course, Toolsteels; Public Auditorium (page 500)

2:00 P.M. American Society for Testing Materials Committee A-7 on Malleable Iron; Hotel Statler

4:00 P.M. War Production Meeting on Surface Protection; Public Auditorium (page 507)

10:30 P.M. 1942 National Metal Congress and Exposition ends

Technical Meetings

Simultaneous Morning Sessions

Monday, October 12

9:30 A.M. — Heat Treatment
LATTICE ROOM, HOTEL STATLER

Effect of Elements in Solid Solution on Hardness and Response to Heat Treatment of Iron Binary Alloys
by *C. R. Austin*, Pennsylvania State College

Third Element Effects on Hardenability of a Pure Hyper-Eutectoid Iron-Carbon Alloy
by *C. R. Austin*, Pennsylvania State College
W. G. Van Note, North Carolina State College
and *T. A. Prater*, Pennsylvania State College

The Ar″ Range in Some of the Iron-Cobalt-Tungsten Alloys
by *W. P. Sykes*, General Electric Co.

9:30 A.M. — Steel Properties
PARLORS 1, 2 AND 3, HOTEL STATLER

The Effect of Hardness on the Machinability of Six Alloy Steels
by *O. W. Boston* and *L. V. Colwell*, University of Michigan

Carburizing Characteristics of 0.20% Carbon Alloy and Plain Carbon Steels
by *G. K. Manning*, Republic Steel Corp.

The Metallography of Galvanized Sheet Steel Using a Specially Prepared Polishing Medium With Controlled pH
by *D. H. Rowland* and *O. E. Romig*, Carnegie-Illinois Steel Corp.

9:30 A.M. — Testing
BALLROOM, HOTEL STATLER

Bursting Tests on Notched Alloy Steel Tubing
by *G. Sachs* and *J. D. Lubahn*, Case School of Applied Science

Notched Bar Tensile Tests on Heat Treated Low Alloy Steels
by *G. Sachs* and *J. D. Lubahn*, Case School of Applied Science

Stress-Strain Measurements in the Drawing of Cylindrical Cups
by *E. L. Bartholomew, Jr.*, Massachusetts Institute of Technology

Fatigue Strength of Normalized and Tempered Versus as-Forged Full Size Railroad Car Axles
by *O. J. Horger* and *T. V. Buckwalter*, Timken Roller Bearing Co.

Tuesday, October 13

9:30 A.M. — Hardenability
LATTICE ROOM, HOTEL STATLER

The End-Quench Test: Reproducibility
by *Morse Hill*, Wright Field

The End-Quench Test: Hardenability of Aircraft Steels and Its Representation
by *Morse Hill*, Wright Field

Hardenability Control of a 1% Carbon Steel
by *G. R. Barrow* and *Gilbert Soler*, Timken Roller Bearing Co.

9:30 A.M. — Molybdenum Steels
BALLROOM, HOTEL STATLER

The Alpha Iron Lattice Parameter as Affected by Molybdenum, and an Introduction to the Problem of the Partition of Molybdenum in Steel
by *F. E. Bowman*, *R. M. Parke* and *A. J. Herzig*, Climax Molybdenum Co.

The Effect of Molybdenum on the Isothermal, Sub-Critical Transformation of Austenite in Eutectoid and Hyper-Eutectoid Steels
by *J. R. Blanchard*, *R. M. Parke* and *A. J. Herzig*, Climax Molybdenum Co.

The Effect of Molybdenum on the Rate of Diffusion of Carbon in Austenite
by *J. L. Ham*, *R. M. Parke* and *A. J. Herzig*, Climax Molybdenum Co.

9:30 A.M. — Research Methods
PARLORS 1, 2 AND 3, HOTEL STATLER

The Method of Thin Films for the Study of Inter-Metallic Diffusion and Chemical Reactions at Metallic Surfaces
by *H. S. Coleman* and *H. L. Yeagley*, Pennsylvania State College

On the Location of Flaws by Stereo-Radiography
by *James Rigbey*, Ford Motor Co. of Canada

The Fluorescent Penetrant Method of Detecting Discontinuities
by *Taber de Forest*, Magnaflux Corp.

Lecture Course on Toolsteels

Every Afternoon; Meeting Room C, Public Auditorium

Monday, 5:00 P.M. — Definition and Classification of Toolsteels
by *H. G. Johnstin*

Tuesday, 5:00 P.M. — Effect of Alloying Elements
by *R. S. Rose*

Wednesday, 5:00 P.M. — Carbon Toolsteels
by *R. B. George*

Thursday, 5:00 P.M. — Chromium and Tungsten Steels for Hot Work or Cold Work
by *G. A. Roberts*

Friday, 2:00 P.M. — High Speed Steels
by *James P. Gill*

(All speakers are members of metallurgical staff, Vanadium-Alloys Steel Co.)

Technical Meetings

9:00 A.M., Wednesday, October 14

Annual Meeting of the American Society for Metals
BALLROOM, HOTEL STATLER

1942 Edward de Mille Campbell Memorial Lecture
by *John Chipman*, Massachusetts Institute of Technology

Simultaneous Morning Sessions

Thursday, October 15

9:30 A.M. — Formation of Austenite
BALLROOM, HOTEL STATLER

A Metallographic Study of the Formation of Austenite From Aggregates of Ferrite and Cementite in an Iron-Carbon Alloy of 0.5% Carbon
by *T. G. Digges* and *S. J. Rosenberg*, National Bureau of Standards

Influence of Initial Structure and Rate of Heating on the Austenitic Grain Size of 0.5% Carbon Steels and Iron-Carbon Alloy
by *T. G. Digges* and *S. J. Rosenberg*, National Bureau of Standards

The Mechanism and the Rate of Formation of Austenite From Ferrite-Cementite Aggregates
by *G. A. Roberts*, Vanadium-Alloys Steel Co.
and *R. F. Mehl*, Carnegie Institute of Technology

9:30 A.M. — Strength of Metals
PARLORS 1, 2 AND 3, HOTEL STATLER

The Tantalum-Carbon System
by *F. H. Ellinger*, General Electric Co.

Influence of Strain Rate on Strength and Type of Failure of Carbon-Molybdenum Steel at 850, 1000 and 1100° F.
by *R. F. Miller* and *G. V. Smith*, U. S. Steel Corp.
and *G. L. Kehl*, Columbia University

Rupture Tests at 200° C. on Some Copper Alloys
by *E. R. Parker* and *C. Ferguson*, General Electric Co.

9:30 A.M. — Steelmaking
LATTICE ROOM, HOTEL STATLER

Corrosion of Water Pipes in a Steel Mill
by *C. L. Clark*, Timken Roller Bearing Co.
and *W. J. Nungester*, University of Michigan

A Study of the Iron-Rich Iron-Manganese Alloys
by *A. R. Troiano*, University of Notre Dame
and *F. T. McGuire*, University of Kentucky

The Induction Furnace as a High Temperature Calorimeter and the Heat of Solution of Silicon in Liquid Iron
by *John Chipman* and *N. J. Grant*, Massachusetts Institute of Technology

Friday, October 16

9:30 A.M. — Toolsteels
BALLROOM, HOTEL STATLER

The Hardening of Toolsteels
by *Peter Payson* and *J. L. Klein*, Crucible Steel Co. of America

The Kinetics of Austenite Decomposition in High Speed Steel
by *Paul Gordon* and *Morris Cohen*, Massachusetts Institute of Technology
and *Robert S. Rose*, Vanadium-Alloys Steel Co.

The Tempering of Two High Carbon, High Chromium Steels
by *Otto Zmeskal*, Illinois Institute of Technology
and *Morris Cohen*, Massachusetts Institute of Technology

9:30 A.M. — Cold Work
PARLORS 1, 2 AND 3, HOTEL STATLER

Some Aspects of Strain Hardenability of Austenitic Manganese Steel
by *D. Niconoff*, Republic Steel Corp.

The Precipitation Reaction in Aged Cold Rolled 1% Cd-Cu: Its Effects on Hardness, Conductivity, and Tensile Properties
by *R. H. Harrington* and *L. E. Cole*, General Electric Co.

The Effect of Moderate Cold Rolling on the Hardness of the Surface Layer of 0.34% Carbon Steel Plates
by *Harry K. Herschman*, National Bureau of Standards

9:30 A.M. — Non-Ferrous Alloys
LATTICE ROOM, HOTEL STATLER

The Metallography of Commercial Magnesium Alloys
by *J. B. Hess* and *P. F. George*, Dow Chemical Co.

Study of Inverse Segregation Suggests New Method of Making Certain Alloys
by *M. L. Samuels*, Babcock & Wilcox Tube Co.
A. R. Elsea and *K. Grube*, Battelle Memorial Institute

Effects of Various Solute Elements on the Hardness and Rolling Texture of Copper
by *R. M. Brick*, Yale University
D. L. Martin, General Electric Co.
and *R. P. Angier*, Handy & Harman

Group Meetings on War Products

Monday Afternoon, October 12, 1942

2:00 P.M. — Metallurgical Aspects of the National Emergency Steels
MUSIC HALL (PUBLIC AUDITORIUM)

CHAIRMAN: *Charles M. Parker*
Secretary of General Technical Committee
American Iron & Steel Institute

SUMMARIZER: *Marcus A. Grossmann*
Director of Research
Carnegie-Illinois Steel Corp.

The End-Quench Test for Hardenability and Its Application
by *Walter E. Jominy*, Chief Metallurgist
Dodge-Chicago Plant, Chrysler Corp.

S-Curves of NE Steels, and Their Use in the Planning of Heat Treatment Schedules
by *R. L. Rickett*, Research Laboratory
U. S. Steel Corp.

Hardenability and Uniformity of NE Steels, and a Comparison with S.A.E. Steels
by *Glenn C. Riegel*, Chief Metallurgist
Caterpillar Tractor Co.

Physical Properties of NE Steels at Normal and Higher Working Temperatures
Speaker to be announced

Annealing the NE Steels for Machinability (Fast Schedules for Desirable Microstructures)
by *Lloyd E. Webb*, Metallurgist
Frost Gear & Forge Co.

Heat Treating and Carburizing NE Steels (Speed and Character of Case)
by *Thomas A. Frischman*, Chief Metallurgist
Axle Division, Eaton Mfg. Co.

General Discussion by the Audience

Questions and Answers

Summary of Important Points
by *Marcus A. Grossmann*

IN ORDER to concentrate on Increased Production of War Products — the general theme of this War Production Edition of the National Metal Congress — all ASM Technical Sessions are to be held in the mornings, leaving afternoons and evenings open for group meetings on Increased Production of War Products. These meetings are patterned after the successful forums of last year's convention. A panel of experts sits before microphones; each in turn gives a 10-min. off-the-record discussion of his specialty, and is ready to answer questions from the audience. The subject is then open for general discussion by the audience, and finally the summarizer emphasizes the important points that have arisen. (ASMembers, too shy to ask questions from the floor, may send them in advance to War Production Sessions, National Metal Congress, 7301 Euclid Ave., Cleveland, or hand them to the chairman before or during the meeting.)

2:00 P.M. — Better Practices in the Working of Aluminum Sheet
MEETING ROOM A, PUBLIC AUDITORIUM

CHAIRMAN: *Reid B. Gray*
Chief of Laboratories
Glenn L. Martin Co.

SUMMARIZER: *Edgar H. Dix, Jr.*
Assistant Director, Aluminum Research
Laboratories, Aluminum Co. of America

Forming Characteristics (Deep Drawing Properties) and Tests Therefor
by *V. N. Krivobok*, Chief Metallurgist
Lockheed Aircraft Co.

Proper Heat Treatment for Formability, Strength, or High Corrosion Resistance
by *John W. Dunn*, Director of Quality
Curtiss-Wright Corp., Airplane Div.

Hardness Tests; Their Relationship to Strength, and Their Limitations
by *Richard L. Templin*, Chief Engineer of Tests
Aluminum Co. of America

Spot Welding in Production
by *E. S. Jenkins*
Curtiss-Wright Corp., Airplane Division

Inspection of Spot Welded Joints
by *George S. Mikhalapov*, Chairman
A.W.S. Aircraft Welding Research Committee

Correct Anodizing and Other Surface Treatments
Speaker to be announced

General Discussion by the Audience

Questions and Answers

Summary of Important Points
by *Edgar H. Dix, Jr.*

4:00 P.M. — Training Men and Women for New Jobs
MEETING ROOM B, PUBLIC AUDITORIUM

CHAIRMAN: *Oscar Grothe*
Vice-President, White Sewing Machine Co.
and District Representative
War Manpower Commission

SUMMARIZER: *W. T. Clayton*
Manager, Aircraft Training Division
Goodyear Aircraft Corp.

A Demonstration of Aptitude Tests for Selecting Trainees
by *Joseph F. Kopas*, Director, Testing & Guidance Dept.
Fenn College

The Fundamental Plan for Job Instructor Training ("Teaching the Teacher How to Teach")
by *L. O. Mellen*, Assistant District Representative
Training Within Industry Division
War Manpower Commission

Demonstration of Technique of Training the Job Instructor
by *C. D. Heiser*, Training Consultant
"Training Within Industry"

How It Works in a Metallurgical Plant
by *Lloyd G. Depner*, Training Supervisor, Cuyahoga Works
American Steel & Wire Co.

Monday Evening, Oct. 12

8:00 P.M. — Doing More With What Alloys We Have by Using NE Steels (Successes and Difficulties Experienced by Large Users)
MUSIC HALL (PUBLIC AUDITORIUM)

CHAIRMAN: *John Mitchell*
Metallurgical Engineer, Alloy Steels
Carnegie-Illinois Steel Corp.

SUMMARIZER: *Herbert J. French*
Technical Consultant, War Production Board
(President-Elect)

Experience in Use of NE Steels by the Automotive Truck and Allied Industries
by *W. Paul Eddy, Jr.*, Metallurgist
General Motors Truck & Coach Division

Experience in Use of NE Steels by the Oil Well Drilling and Equipment Industries
by *B. B. Wescott*
Gulf Research & Development Co.

Experience in Use of NE Steels by the Tractor and Farm Implement Industries
by *Hyman Bornstein*, Chief Metallurgist
Deere & Co.

Experience in Use of NE Steels by the Aircraft Engine Manufacturers
by *Robert L. Heath*, Chief Metallurgist
Allison Engine Division, General Motors Corp.

Experience in Use of NE Steels by the Machine Tool Builders
by *H. Stanley Binns*, Metallurgist
Cincinnati Milling Machine Co.

NE Steels From the Steel Producer's Standpoint
by *Charles H. Herty, Jr.*, Assistant to Vice-President
Bethlehem Steel Co.

8:00 P.M. — Manufacture and Heat Treatment of Magnesium Castings
MEETING ROOM A, PUBLIC AUDITORIUM

CHAIRMAN: *Arthur W. Winston*
Foundry Division, Dow Chemical Co.

SUMMARIZER: *V. N. Krivobok*
Chief Metallurgist, Lockheed Aircraft Co.

Formulation and Control of Foundry Sand
by *William F. Rose*, Chief of Sand Laboratory
Wright Aeronautical Corp.

Core Sand and Core Making Problems
by *M. E. Gantz*, American Magnesium Corp.

Precautions in Melting and Pouring Magnesium
by *Manley E. Brooks*, Foundry Metallurgist
Dow Chemical Co.

Labor Saving Methods in Founding and Cleaning
by *J. W. Klayer*, Chief Metallurgist
Aluminum Industries, Inc.

Heat Treatment of Castings, and Requirements for Idle Furnaces That May be Converted
by *Robert T. Wood*, Chief Metallurgist
American Magnesium Corp.

Inspection Problems
by *L. E. Pearch*, Wellman Bronze & Aluminum Co.

8:00 P.M. — Salvage of Broken Tools and Maintenance of Equipment
MEETING ROOM B, PUBLIC AUDITORIUM

(*Program being organized at press-time*)

Tuesday Afternoon, Oct. 13

2:00 P.M. — Doing More With Available Toolsteels
MUSIC HALL (PUBLIC AUDITORIUM)

CHAIRMAN: *A. H. d'Arcambal*
Vice-President, Pratt & Whitney

SUMMARIZER: *James P. Gill*
Chief Metallurgist
Vanadium-Alloys Steel Co.

The Critical Situation in Tool Alloys
by *Burns George*, Technical Consultant, Tool & Die Steel Unit
War Production Board

Cutting Tools Containing Little or no Vanadium; Heat Treatment and Use
by *David I. Dillworth*, Halcomb Steel Co.

Savings Through Standardization to Both Manufacturer and User
by *Norman I. Stotz*, Metallurgical Engineer
Universal-Cyclops Steel Corp.

Saving Tool Materials by Use of Inserts and Tips (Carbide)
by *Donald G. Clark*, Vice-President
Firth-Sterling Steel Co.

Developments in the Art of High Speed Cutting of Harder Steels
by *Hans Ernst*, Research Director
Cincinnati Milling Machine Co.

Conservation and Salvage of Cutting Tools (Toolsteels)
by *A. L. Boyle*, Director of Economic Research
International Harvester Co.

Summary of Important Points
by *James P. Gill*

4:00 P.M. — Interpretation of Magnaflux and Other Surface Inspection Tests
MEETING ROOM A, PUBLIC AUDITORIUM

CHAIRMAN: *Alfred V. de Forest*
Professor of Mechanical Engineering
Massachusetts Institute of Technology

SUMMARIZER: to be announced

Interpretation, Potency, Standards and Correct Application of Magnaflux in Steel Bar Manufacture
by *A.D. Beeken, Jr.*, Metallurgist
Vulcan Crucible Steel Co.

Interpretation, Potency, Standards and Correct Application of Magnaflux Testing of Finished Parts
by *John Goldthwaite*, Testing Engineer
Allison Engine Division, General Motors Corp.

Interpretation, Potency, Standards and Correct Application of Magnaflux Testing of Steel Locomotive Parts and Railroad Rolling Stock
by *Ray McBrian*, Engineer of Tests
Denver & Rio Grande Western Railway Co.

Use of Fluorescent Liquids to Locate Surface Defects
by *Greer Ellis*, Manager, Stresscoat Division
Magnaflux Corp.

Use of Chromate and Other Dips to Prove Sound Surfaces on Aluminum and Magnesium Parts
by *P. V. Faragher*
Aluminum Co. of America

Electro-magnetic Inspection of Tubing, Strip, Rod, etc., for Uniformity
by *Horace C. Knerr*, President
Metlab, Inc.

General Discussion by the Audience

Group Meetings on War Products

Tuesday Evening, October 13, 1942

8:00 P.M. — Selecting the Proper Die Steel for Mass Production
MEETING ROOM A, PUBLIC AUDITORIUM

CHAIRMAN: *Benjamin F. Shepherd*
Chief Metallurgist, Ingersoll-Rand Co.

SUMMARIZER: *H. E. Replogle*
Universal-Cyclops Steel Corp.

Die Steels for Manufacturing Die Castings
by *Joseph C. Fox*, Chief Metallurgist
Doehler Die Casting Co.

Improving the Life and Accuracy of Steel Forging Dies
by *J. A. Succop*, Metallurgist, Heppenstall Co.

Ways and Means of Increasing Die Life in the Cupping and Deep Drawing of Brass
by *W. N. Van Tassel*, Metallurgist, Scovill Mfg. Co.

Dies for Hot Forging of Aluminum (Hammers and Presses)
by *L. W. Davis*, Chief Metallurgist, Forgings Division
Aluminum Co. of America

Dies for Stamping and Drawing of Aluminum Sheet
by *V. N. Krivobok*, Chief Metallurgist
Lockheed Aircraft Corp.

Standardization of Drawing Dies for Small Arms Ammunition
by *A. E. Glen*, Assistant to General Sales Manager
Carboloy Co., Inc.

Summary of Important Points
by *H. E. Replogle*

8:00 P.M. — Speeding Production by Improved Metal-Cutting Practices
MUSIC HALL (PUBLIC AUDITORIUM)

CHAIRMAN: *Hans Ernst*
Research Director
Cincinnati Milling Machine Co.

SUMMARIZER: *Orlan W. Boston*
Professor of Metal Processing
University of Michigan

Best Metallurgical Conditions for Machinability
by *Harry B. Knowlton*, Chief Metallurgist
Gas Power Engineering Dept., International Harvester Co.

Improving Machinability of Steel by Severe Cold Working
Speaker to be announced

Cutting Aluminum Extrusions at Cyclonic Speed
Speaker to be announced

Recent Developments in Hard Carbides
Speaker to be announced

Increasing Tool Life and Work-Quality by Better Tool Finishing
by *W. H. Wagner*, Research Engineer, Norton Company

Cutting Fluids and Proper Use
by *Oscar Maag*, Chemical Department
Timken Roller Bearing Co.

General Discussion by the Audience

Questions and Answers

Summary of Important Points
by *Orlan W. Boston*

8:00 P.M. — Use and Interpretation of Radiography as an Inspection Method
MEETING ROOM B, PUBLIC AUDITORIUM

CHAIRMAN: *H. H. Lester*
Principal Physicist, Watertown Arsenal

SUMMARIZER: *Kent R. Van Horn*
Research Metallurgist
Aluminum Co. of America

Selection and Training of Operators
by *O. R. Carpenter*, Babcock & Wilcox Co.

Standardization of Technique and Material in Production
by *Tom A. Triplett*, President, Triplett & Barton

Acceptance and Rejection Standards for Light Alloy Castings
by *W. H. Burroughs*, Assistant Chief Inspector
Glenn L. Martin Aircraft Co.

Sampling (Determination of Proportion of Castings That Should be Radiographed)
by *James Bly*
Pratt & Whitney Aircraft Division

Limitations of Radiography as an Inspection Method (Proper and Improper Applications)
by *Arthur J. Sikora*, Director of Laboratory
Wright Aeronautical Corp.

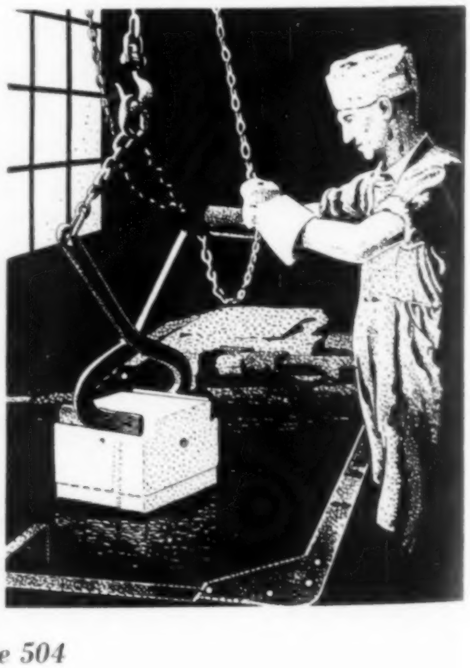
New Developments in Equipment, Films, Technique
by *L. W. Ball*
National Research Laboratories of Canada

Reports, Techniques, and Standard Practices to Comply with Government Specifications
by *Robert Katz*, Radiologist, Materiel Center
Army Air Forces, Wright Field

General Discussion by the Audience

Questions and Answers

Summary of Important Points
by *Kent R. Van Horn*



Wednesday Afternoon, October 14, 1942

2:00 P.M. — Making More Steel in Our Openhearth Plants
MUSIC HALL (PUBLIC AUDITORIUM)

CHAIRMAN: *Wm. C. Buell, Jr.*
Steel Plant Consultant
Arthur G. McKee & Co.

SUMMARIZER: *Earle C. Smith*
Chief Metallurgist, Republic Steel Corp.

Speeding Charging Time by (*a*) Trimmer Charge Boxes, (*b*) Close Timing of Charging Drags, (*c*) Handling Hot Metal
by *J. W. Cahill*, Openhearth Superintendent
Republic Steel Corp.

Long and Uninterrupted Furnace Campaigns (Roof Maintenance, Hot Repairs, Refractory Qualities, Short Rebuilding Time)
Speaker to be announced

Working of High Iron Charges by (*a*) Minimizing Silicon in Basic Iron, (*b*) Disposal of Run-Off Slag, (c) Oxidation With Ore or Stone
by *C. R. FonDersmith*, Openhearth Superintendent
American Rolling Mill Co.

The Openhearth as a Direct Reducer of Iron From Ore: (*a*) Precautions to Avoid Loss of Production and Quality, (*b*) Comparative Value of Lump Ore, Sinter, or Briquettes
by *Clyde Denlinger*, Openhearth Superintendent
Bethlehem Steel Co.

Making the Most of Scrap by (*a*) Segregation by Alloy Content, (*b*) Scheduling Use of Sub-Standard Grades
by *Gilbert Soler*, Manager of Research
Timken Roller Bearing Co.

Cooperation With Blooming Mill to Get Maximum Yield From Ingots (Also Good Pit Practices to Achieve Same Ends)
Speaker to be announced

Solving the Personnel Problem in the Expansion of Plants and Loss of Key Men to the Services
by *E. A. Schwartz*, Chairman, Openhearth Committee
Republic Steel Corp.

4:00 P.M. — Using Less Alloys in Steel Melting by the Use of Addition Agents (Intensifiers)
MEETING ROOM A, PUBLIC AUDITORIUM

CHAIRMAN: *Carl C. Henning*
General Metallurgist
Jones & Laughlin Steel Corp.

SUMMARIZER: *L. E. Ekholm*
Metallurgical Engineer
Alan Wood Steel Co.

How to Use These Addition Agents
Speaker to be announced

What Alloys Can Be Saved
by *Walter Crafts*, Metallurgist
Union Carbide & Carbon Research Laboratories

What Types of Steel Can be Benefited
by *A. W. Demmler*, Metallurgical Engineer
Vanadium Corp. of America

Extra Properties Obtainable in a Treated Steel
by *George F. Comstock*, Metallurgist
Titanium Alloy Mfg. Co.

General Discussion by the Audience

Questions and Answers

Summary of Important Points
by *L. E. Ekholm*

2:00 P.M. — Problems Associated with the Large Expansion of the Steel Foundry Industry
MEETING ROOM A, PUBLIC AUDITORIUM

CHAIRMAN: *Frank G. Steinebach*
Editor, *The Foundry*

SUMMARIZER: *Charles W. Briggs*
Technical Advisor
Steel Founders' Society of America

The Problem of Obtaining Adequate Melters and Molders
by *F. A. Melmoth*, Vice-President
Detroit Steel Casting Co.

The Long Range Personnel Problem; Apprentice Training Programs
by *Elmer Reynolds*
Field Representative on Apprentice Training, W.P.B.

Conversion of Iron Foundries Into Steel Foundries
Speaker to be announced

Converting Cupola Iron to Steel
by *W. J. Phillips*, Assistant General Manager
Symington-Gould Corp.

Duplex (or Triplex) Steel—Cupola to Converter to Electric Furnace
Speaker to be announced

Scraping up the Scrap (and Other Raw Materials)
by *O. W. McMillen*
National Malleable & Steel Castings Co.

Conversion of Idle Furnace Equipment to the Heat Treatment of Steel Castings
by *Charles S. Pearce*, Managing Director
Porcelain Enamel Institute

4:00 P.M. — Use of Powdered Metals in War Products and Tools
MEETING ROOM B, PUBLIC AUDITORIUM

CHAIRMAN: *Andrew J. Langhammer*
Manager, Amplex Division, Chrysler Corp.

SUMMARIZER: *Philip M. McKenna*
President, McKenna Metals Co.

Raw Material, Processes and Uses of Copper Powders
by *Paul E. Weingart*
U. S. Metals Refining Co.

Supply of Necessary Non-Ferrous Powders to Blend With Copper
by *Don Noel*
Metals Disintegrating Co.

Manufacture of Iron Powder of High Quality
by *John Wulff*, Associate Professor, Department of Metallurgy
Massachusetts Institute of Technology

Substitution of Iron for Non-Ferrous Powders
by *Earl S. Patch*, Sales Manager, Moraine Products Division
General Motors Corp.

Supply and Use of Tungsten Powders for Tools and Electrical Equipment
by *Zay Jeffries*, Chairman of the Board
The Carboloy Co.

Recent Achievements in Powder Metallurgy
by *Gregory J. Comstock*, Professor of Powder Metallurgy
Stevens Institute of Technology

General Discussion by the Audience

Questions and Answers

Summary of Important Points
by *Philip M. McKenna*

Group Meetings on War Products

Wednesday Evening, October 14, 1942

8:00 P.M. — Increasing the Yield of Electric Furnaces (Electric Steel Practice)
MEETING ROOM A, PUBLIC AUDITORIUM

CHAIRMAN: *J. H. Chivers*
Melting Superintendent
Firth-Sterling Steel Co.

SUMMARIZER: *David J. Giles*
Vice-President, Latrobe Electric Steel Co.

Minimizing Down-Time Between Heats
by *Harry F. Walther*, Assistant Superintendent of Melting
Timken Roller Bearing Co., Steel & Tube Division

Speeding Output by Use of Hot Metal and Duplexing
by *R. J. McCurdy*, Electric Furnace Dept.
Republic Steel Corp.

Proper Relationship of Power Input, Transformers, and Furnace Size
by *W. B. Wallis*, President
Pittsburgh Lectromelt Furnace Corp.

Essential Nature of Chemical Reactions, and How to Provide for Them in Shortest Time
by *Harold E. Phelps*, Electric Furnace Superintendent
Rotary Electric Steel Co.

Can "Electric Steel" Quality be Got from Openhearth Steel?
by *Ernest R. Johnson*, Assistant Chief Metallurgical Engineer
Alloy Division, Republic Steel Corp.

Special Handling of Tender Analyses
Speaker to be announced

General Discussion by the Audience

Summary of Important Points
by *David J. Giles*

8:00 P.M. — Recruiting, Training and Handling Inspectors of Metallurgical Materiel
MUSIC HALL (PUBLIC AUDITORIUM)

CHAIRMAN: *William E. Wickenden*
President, Case School of Applied Science

SUMMARIZER: *Max Robinson*
Acting Dean, School of Engineering
Fenn College

Recruiting of Inspection Personnel
by *James A. Campbell*, Special Representative
U. S. Civil Service Commission

Metallurgical Fundamentals of the Training Course
by *LeRoy L. Wyman*, Research Laboratory
General Electric Co.

Coordination of Class-Room Work With Training on the Job
by Lt. Col. *George M. Enos*
Cincinnati Ordnance District

Latitude of Inspection, in Terms of Meeting Both the Intent of the Specifications and the Production Schedule
by *John W. W. Sullivan*, Director of Training
Cleveland Ordnance District

Women as Inspectors
by *C. H. Dustin*, Special Representative
U. S. Office of Education

Managing a Large Inspection Staff
by *Maurice N. Hester*, Chief Inspector
Willys-Overland Motors, Inc.

General Discussion by the Audience

Summary of Important Points
by *Max Robinson*

Thursday Afternoon, October 15, 1942

2:00 P.M. — Making Better and Prompter Use of Secondary Metals
MEETING ROOM A, PUBLIC AUDITORIUM

CHAIRMAN: *Frederic W. Willard*
President, Nassau Smelting & Refining Co.

SUMMARIZER: *Ernest E. Thum*
Editor, *Metal Progress*

Putting Scrap Into Copper Alloy Ingots That Meet Ordnance Requirements
by *William Romanoff*
Vice-President & Technical Superintendent
H. Kramer & Co.

Aluminum Secondaries (Harmful and Harmless "Impurities")
by *Walter Bonsack*, Chief Metallurgist
National Smelting Co.

Tin Reclamation
by *Frederic W. Willard*, President
Nassau Smelting & Refining Co.

Recovery of Lead Alloys, Especially Babbitts and Solders
by *Oscar E. Harder*, Assistant Director
Battelle Memorial Institute

Handling Very Impure Domestic Scrap Collections
by *E. W. Roath*, Copper Consultant, Conservation and Substitution Branch, War Production Board

Two More Programs This Afternoon
See next column

Thursday's Program, Continued

2:00 P.M. — Speeding the Job by Better Production Heating for Softening Prior to Hot Work, or for Annealing
MUSIC HALL (PUBLIC AUDITORIUM)

CHAIRMAN: *E. G. de Coriolis*
Research Director
Surface Combustion Corp.

SUMMARIZER: *Frederick C. Young*
Head, Chemical and Metallurgical Department, Ford Motor Co., Rouge Plant

Control of Scale in Soaking Pits
by *Frank Leahy*, Superintendent, Fuel Engineering Dept. Youngstown Sheet & Tube Co.

Control of Scale in Reheating Furnaces
by *Julius H. Strassburger*, Combustion Engineer Weirton Steel Co.

Control of Scale in Forging Furnaces
by *Waldemar Naujoks*, Chief Metallurgist Steel Improvement & Forge Co.

Rapid Annealing Cycles for Machinability
by *Roy W. Roush*, Chief Metallurgist Timken-Detroit Axle Co.

Relative Advantages of Normalizing and Annealing to (*a*) Production and (*b*) Use
by *J. D. Armour*, Chief Metallurgist Union Drawn Steel Div., Republic Steel Corp.

Surface Protection During Process Annealing After Deep Drawing
Speaker to be announced

Conversion of Old Furnaces to War Production
by *James Ludley Miller*, Assistant Combustion Engineer Republic Steel Corp.

4:00 P.M. — Practical Programs for Segregation, Collection and Reclamation of Metal Scrap
MEETING ROOM B, PUBLIC AUDITORIUM

CHAIRMAN: to be announced

SUMMARIZER: *R. H. Schmidt*
Staff Assistant, Headquarters Mfg. Div. Westinghouse Electric & Mfg. Co.

Segregation of Active Scrap (in Process)
by *R. W. Hughes*, Superintendent of Reclamation Caterpillar Tractor Co.

Steps to Minimize Amount of Scrap Produced
by *J. L. Cannon*, Chief Chemist, Hyatt Bearings Div. General Motors Corp.

Plant Organization Necessary in a Large Plant
by *Frank D. Kent*, Supervisor, Surplus Materials Sales Order and Contract Division, Wright Aeronautical Corp.

Plant Organization Suitable for a Medium Size Plant
by *E. S. Hoopes*, Assistant General Superintendent Steel & Tubes Division, Timken Roller Bearing Co.

Plant Organization Suitable for a Small Size Plant
by *H. F. Kneen*, General Superintendent Lincoln Electric Co.

Modern Chip Handling Procedure
by *A. M. Perrin*, President, National Conveyors Co.

Disposal of Recoveries
by *Harry J. Beattie*, Apparatus Mfg. Div. General Electric Co.

General Discussion by the Audience

Questions and Answers

Summary of Important Points
by *R. H. Schmidt*

Friday Afternoon, October 16, 1942

2:00 P.M. — Speeding the Job by Better and Faster Production Hardening
MUSIC HALL (PUBLIC AUDITORIUM)

CHAIRMAN: *Robert B. Schenck*
Chief Metallurgist, Buick Motor Division General Motors Corp.

SUMMARIZER: *O. W. McMullan*
Metallurgist, Youngstown Sheet & Tube Co.

Minimum Heat (and Time) Necessary
by *Elbert S. Rowland*, Research Metallurgist Timken Roller Bearing Co.

Improvement of the Quench (e.g., for Armor Piercing Shot)
Speaker to be announced

Control of Warpage (e.g., Armor Plate)
by *H. A. Grove*, Armor Plate Metallurgist Republic Steel Corp.

Surface Hardening by Induction Heating
by *Wm. E. Benninghoff*, Manager, Tocco Department Ohio Crankshaft Co.

Surface Hardening With Oxy-Acetylene Flame
by *John J. Crowe*, Assistant to Vice-President Air Reduction Co.

Surface Hardening by Gas-Air Flames
by *Frederic O. Hess*, President, The Selas Co.

Hardening by Nitriding and Carbo-Nitriding
by *Vernon E. Hense*, Assistant Plant Metallurgist Buick Motor Division, General Motors Corp.

Summary of Important Points
by *O. W. McMullan*

2:00 P.M. — Getting by With Low Tin Alloys
MEETING ROOM A, PUBLIC AUDITORIUM

CHAIRMAN: *Harvey A. Anderson*
Chief, Conservation and Substitution Branch War Production Board

SUMMARIZER: *Carter S. Cole*
Chief, Metals Section, Specifications Branch War Production Board

Bronzes That Conserve Strategic Metals
by *Chester B. Hamilton, Jr.*, President Hamilton Gear & Machine Co.

Low Tin Bearing Metals
by *E. L. Neiswander*, Buckeye Machine Co.

Some Engineering Problems Concerning Thinner-Walled Bearings for Machinery
by *Carl E. Swartz*, Metallurgist Cleveland Graphite Bronze Co.

Conserving Strategic Metals in Railway Car "Brasses"
by *E. S. Pearce*, President Railway Service and Supply Corp.

Low Tin Solders, Use and Manipulation
by *A. A. Smith, Jr.*, Metallurgist American Smelting & Refining Co.

Electro-Tin and Bonderized Coatings
by *Roger H. Lueck*, Director, Research Department American Can Co.

4:00 P.M. — Methods and Materials for Surface Protection
MEETING ROOM B, PUBLIC AUDITORIUM

(Program Being Organized at Press Time)

American Welding Society Program

Monday, October 12

9:30 A.M. — Presentation of Medals and Prizes
BALLROOM, HOTEL CLEVELAND

10:15 A.M. — Training of Welding Operators and Qualifications
BALLROOM, HOTEL CLEVELAND

Training of Welding Foremen
by *F. H. Achard*, Consolidated Edison Co. of New York

Instruction Methods in Welding Developed by U. S. Office of Education
by *H. K. Hogan*, U. S. Office of Education

2:00 P.M. — Fatigue and Impact
RED ROOM, HOTEL CLEVELAND

Fatigue Strength of Metal Subjected to Combined Stresses
by *L. H. Donnell*, Illinois Institute of Technology

Fatigue Strength of Commercial Butt Welds in Plain Carbon Steel Plates
by *W. M. Wilson*, University of Illinois

Fatigue Tests of Full Thickness Plates With and Without Butt Welds
by *E. C. Huge*, Babcock & Wilcox Co.

Impact Strength of High Alloy Steel Welds
by *E. C. Chapman*, Combustion Eng. Co.

2:00 P.M. — War Production
BALLROOM, HOTEL CLEVELAND

Some Special Applications of Flame Hardening
by *Stephen Smith*, Air Reduction Sales Co.

High Quality Welding — Vertical and Overhead Positions With Alternating Current
by *H. O. Westendarp*, General Electric Co.

Conservation and Effective Use of Equipment and Supplies for Welding and Cutting
by *H. Ullmer*, The Linde Air Products Co.

Welding Gun Mounts
by *W. B. Lair*, York Safe and Lock Co.

7:30 P.M. — Motion Picture Films
RED ROOM, HOTEL CLEVELAND

The Inside of Welding
by General Electric Co.

The Welding of Aluminum
by Aluminum Co. of America

The Welding Technique
by Oklahoma A. & M. College

7:30 P.M. — Industrial Research Dinner
ROSE ROOM, HOTEL CLEVELAND

Tuesday, October 13

9:30 A.M. — Weldability of Steel
BALLROOM, HOTEL CLEVELAND

What Happens to Residual Stresses in Service
by *J. T. Norton* and *D. Rosenthal*, Massachusetts Institute of Technology

Effects of Cooling Rate on the Properties of Arc Welded Joints
by *W. F. Hess*, Rensselaer Polytechnic Institute

Weld Quench Gradient Tests
by *W. H. Bruckner*, University of Illinois

9:30 A.M. — Aircraft Welding (Fuselage)
RED ROOM, HOTEL CLEVELAND

Welding of Airplane Propeller Blades
by *C. A. Liedholm*, Curtiss-Wright Corp.

Welding of New Types of Alloy Steels for Aircraft Structures
by *A. R. Lytle* and *K. H. Koopman*, Union Carbide and Carbon Research Laboratories

Effect of Current on the Welding of X4130 Sheet and Tubing
by *W. T. Tiffin*, University of Oklahoma

2:00 P.M. — Weldability of Steel
BALLROOM, HOTEL CLEVELAND

Weldability of Carbon-Manganese Steels
by *O. E. Harder* and *C. B. Voldrich*, Battelle Memorial Institute

Weldability Tests of Carbon-Manganese Steels
by *C. E. Jackson*, *M. A. Pugacz* and *G. G. Luther*, Naval Research Laboratory

Jominy End-Quench Hardenability Tests on Carbon-Manganese Steels
by *G. A. Timmons*, Climax Molybdenum Co.

Tee-Bend Tests on Carbon-Manganese Steels
by *L. C. Bibber* and *J. Heuschkel*, Carnegie-Illinois Steel Corp.

2:00 P.M. — Aircraft Welding (Sheet)
ASSEMBLY B, HOTEL CLEVELAND

Spot Welding in Aircraft Structures
by *E. S. Jenkins*, Curtiss-Wright Corp.

Standards and Recommended Practices and Procedures for Spot Welding Aluminum Alloys
by *G. S. Mikhalapov*, Aircraft Welding Standards Committee

Arc Welding of Magnesium Alloys
by *W. S. Loose* and *A. R. Orban*, Dow Chemical Co.

Welding — Its Application to Aircraft
by *Francis H. Stevenson*, Vega Aircraft Corp.

2:00 P. M. — Gas Cutting
RED ROOM, HOTEL CLEVELAND

Gas Cutting in Steel Mills
by *S. D. Baumer*, Air Reduction Sales Co.

Improved Methods of Machine Flame Cutting
by *H. E. Rockefeller*, The Linde Air Products Co.

Gas Cutting in Shipbuilding
by *R. F. Helmkamp*, Air Reduction Sales Co.

7:30 P.M. — Fundamental Research Conference
RED ROOM, HOTEL CLEVELAND

American Welding Society Program

Wednesday, October 14

9:30 A.M. — Resistance Welding
ASSEMBLY B, HOTEL CLEVELAND

Refrigerant Cooled Spot Welding Electrodes
by *F. R. Hensel*, *E. I. Larsen* and *E. F. Holt* — P. R. Mallory & Co.

Spot Welding of 0.040-In. Thick X4130 Steel
by *W. F. Hess* and *D. C. Herrschaft* — Rensselaer Polytechnic Institute

Unusual Resistance Welding Developments and Operations
by *R. T. Gillette*, General Electric Co.

Resistance Welding Trench Mortar Fin Assembly
by *J. H. Cooper*, Taylor-Winfield Corp.

9:30 A.M. — Production Welding
RED ROOM, HOTEL CLEVELAND

Welding With Aluminum Bronze
by *Clinton E. Swift*, Ampco Metal, Inc.

Adapting Automatic Electric Welding to Routine Production
by *J. M. Keir*, The Linde Air Products Co.

Welded Steel Tube and Its Application in War Production
by *H. S. Card*, Formed Steel Tube Institute

2:00 P.M. — Resistance Welding
ASSEMBLY B, HOTEL CLEVELAND

The Spot Welding of NAX High Tensile Steel
by *C. R. Schroder*, Great Lakes Steel Corp.

Application of Copper Oxide Rectifiers for Resistance Welding
by *R. L. Briggs*, Thomson Gibb Electric Welding Co.

The Effect of Weld Spacing on the Strength of Spot Welded Joints
by *R. Della-Vedowa* and *M. M. Rockwell* — Lockheed Aircraft Corp.

Preparation of Aluminum Alloy for Spot Welding
by *T. E. Piper*, Northrop Aircraft, Inc.

2:00 P.M. — Welding and Cutting of Ordnance
BALLROOM, HOTEL CLEVELAND

Factors Affecting the Accuracy of Ordnance Machine Cutting
by *Howard Hughey* and *A. H. Yoch* — Air Reduction Sales Co.

Manual and Automatic Welding of Heavy Plate of Hardenable Alloys
by *L. A. Danse*, Cadillac Motor Car Div.

Developments in Cast Iron Welding Rods and Electrodes
by *R. J. Franklin*, Chicago Hardware Foundry Co.

Electric Welding of Mobile Gun Carriages
by *G. E. Campbell*, Pettibone-Mulliken Corp.

Wednesday Program Continued in Next Column

Wednesday Program (Continued)

2:00 P.M. — Shipbuilding
RED ROOM, HOTEL CLEVELAND

Suggested Methods Which Will Increase Welding Production and Decrease Welding Costs
by *J. F. Lincoln*, Lincoln Electric Co.

Distortion and Shrinkage Problems in Ships and Other Large Structures
by *Lamotte Grover*, Air Reduction Co.

Motor Boat Construction and Small Ships
by *W. E. Whitehouse*, Defoe Shipbuilding Co.

Application of Welding in Submarine Construction
by *E. H. Ewertz*, Electric Boat Co.
and *R. D. West*, Manitowoc Shipbuilding Co.

7:30 P.M. — Section Officers Dinner and Conference
ROSE ROOM, HOTEL CLEVELAND

Thursday, October 15

9:30 A.M. — Aircraft Welding
RED ROOM, HOTEL CLEVELAND

Utility Characteristics of Aircraft Electrodes
by *C. B. Voldrich* and *R. D. Williams* — Battelle Memorial Institute

Results of Survey on Current Arc Welding Practice in Aircraft Industry
by *Maurice Nelles*, Western Aircraft Welding Committee

Copper Welding for Aircraft
by *T. V. Buckwalter*, Timken Roller Bearing Co.

9:30 A.M. — Non-Destructive Tests and Inspection
ASSEMBLY B, HOTEL CLEVELAND

Correlation of Metallographic and Radiographic Examinations of Spot Welds in Aluminum Alloys
by *Dana W. Smith* and *Fred Keller* — Aluminum Co. of America

The Magnetic Powder Method for Inspecting Weldments and Castings for Sub-Surface Defects
by *Carleton Hastings*, Watertown Arsenal

Radiographic Inspection of Welded Armor Plates and Castings
by *Don M. McCutcheon*, Ford Motor Co.

Visual Inspection of Arc Welds
by *W. L. Warner*, Watertown Arsenal

2:00 P.M. — Business Meeting
ROSE ROOM, HOTEL CLEVELAND

3:00 P.M. — Board of Directors Meeting
ROOM 1, HOTEL CLEVELAND

International Acetylene Association

Wednesday, October 14

12:00 Noon — Luncheon and Annual Business Meeting
MEZZANINE FLOOR, HOTEL CLEVELAND

American Institute of Mining and Metallurgical Engineers

Monday, October 12

2:00 P.M. — Copper-Base Alloys
(*Institute of Metals Division*)
PINE ROOM, HOTEL STATLER

Phase Diagram of the Copper-Iron-Silicon System From 90% to 100% Copper
by *A. G. H. Andersen*, Consulting Engineer and *W. A. Kingsbury*, Phelps Dodge Corp.

Internal Friction of an Alpha Brass Crystal
by *Clarence Zener*, Washington State College

Note on Some Hardness Changes That Accompany the Ordering of Beta Brass
by *Cyril Stanley Smith*, War Metallurgy Commission, National Academy of Sciences, National Research Council

2:00 P. M. — Magnetite Reduction; Chromizing; Weldability
(*Iron and Steel Division*)
EUCLID BALLROOM, HOTEL STATLER

A Study of Low Temperature Gaseous Reduction of a Magnetite
by *M. C. Udy* and *C. H. Lorig*, Battelle Memorial Institute

Chromizing of Steel
by *I. R. Kramer* and *Robert H. Hafner*, Naval Research Laboratory

Calculated Hardenability and Weldability of Carbon and Low Alloy Steels
by *C. E. Jackson* and *G. G. Luther*, Naval Research Laboratory

Tuesday, October 13

9:30 A.M. and 2:00 P.M. — Symposium on Rare and Precious Metals
(*Institute of Metals Division*)
PINE ROOM, HOTEL STATLER

Rare Metals and the War Effort
by *W. P. Sykes*, Conservation Division, WPB

The Rare Metals and Why They Are Rare
by *R. S. Dean*, U. S. Bureau of Mines

The Use of Silver During the Emergency
by *R. H. Leach* and *John L. Christie*, Handy & Harman

The Effect of Certain Elements on the Rate of Tarnishing of Silver Alloys
by *W. E. Campbell*, Bell Telephone Laboratories

Bismuth Solders and Other New Applications of Bismuth
by *A. J. Phillips*, American Smelting & Refining Co.

Elements a la Carte: A Summary of the Status of Artificially Produced Elements and Some of Their Applications
by *K. K. Darrow*, Bell Telephone Laboratories

Rare Elements in the Electrical Industry
by *Porter H. Brace*, Westinghouse Electric & Mfg. Co.

Rare Elements in the Glass Industry
by *M. B. Vilensky*, Owens-Corning Fiberglas Corp.

Notes on Refractory Metal-Base Compound Materials
by *C. G. Goetzel*, American Sinteel Co.

Time-to-Fracture Tests on Platinum, Platinum-Iridium, and Platinum-Rhodium Alloys
by *H. E. Stauss*, Baker and Co., Inc.

10:00 A.M. — Tensile Properties and Hardenability
(*Iron and Steel Division*)
EUCLID BALLROOM, HOTEL STATLER

True Stress-Strain Relations at High Temperatures by the Two-Load Method
by *C. W. MacGregor*, Massachusetts Institute of Technology and *L. E. Welsh*, Bakelite Corp.

The Calculation of the Tensile Strength of Normalized Steels From Chemical Composition
by *F. M. Walters, Jr.*, Naval Research Laboratory

Effect of Silicon on Hardenability
by *Walter Crafts* and *J. L. Lamont*, Union Carbide and Carbon Research Laboratories

Noon — Iron and Steel Division's Executive Committee Luncheon
PARLOR K, HOTEL STATLER

2:00 P.M. — Openhearth Steel
(*Iron and Steel Division*)
EUCLID BALLROOM, HOTEL STATLER

Duplex Process for Manufacture of Basic Openhearth Steel
by *H. B. Emerick* and *S. Feigenbaum*, Jones and Laughlin Steel Corp.

The Effects of Tin on the Properties of Plain Carbon Steel
by *J. W. Halley*, Inland Steel Co.

Cause of Bleeding in Ferrous Castings
by *C. A. Zappfe*, Battelle Memorial Institute

Evening — Annual Dinner of the Institute of Metals Division and the Iron and Steel Division
EUCLID BALLROOM, HOTEL STATLER

Wednesday, October 14

Noon — Institute of Metals' Executive Committee Luncheon
PARLOR K, HOTEL STATLER

2:00 P.M. — Aluminum, Magnesium and Lead
(Institute of Metals Division)
PINE ROOM, HOTEL STATLER

The Rate of Precipitation of Silicon From the Solid Solution of Silicon in Aluminum
by *L. K. Jetter*, Aluminum Co. of America and *Robert F. Mehl*, Carnegie Institute of Technology

Equilibrium Diagrams and Lattice Spacing Relationships in the Systems Magnesium-Tin and Magnesium-Lead
by *Geoffrey V. Raynor*, The University Museum Oxford, England

Constitution of Lead-Rich Lead-Antimony Alloys
by *W. S. Pellini* and *F. N. Rhines*, Carnegie Institute of Technology

2:00 P.M. — Physical Chemistry of Steel Making
(Iron and Steel Division)
EUCLID BALLROOM, HOTEL STATLER

Silicon-Oxygen Equilibria in Liquid Iron
by *C. A. Zapffe* and *C. E. Sims*, Battelle Memorial Institute

Equilibria of Liquid Iron and Simple Basic and Acid Slags in a Rotary Induction Furnace
by *C. R. Taylor*, American Rolling Mill Co. and *John Chipman*, Massachusetts Institute of Technology

Thursday, October 15

Noon — Physical Chemistry of Steelmaking Committee Luncheon
PARLOR L, HOTEL STATLER

The Wire Association

[A registration fee of $5.00 is required. Admission will be by badge only.]

Monday, October 12

10:30 A.M. — Directors' Meeting
HOTEL CARTER

12:00 M. — Program Committee Luncheon
HOTEL CARTER

2:30 P.M. — First Technical Session
HOTEL CARTER

Opening Address
by *Carl E. Johnson*, President, Wire Association

The Wire Industry's Part in Industrial Conservation
by *Ivon B. Tilyou*, Industrial Salvage Section, WPB

Mines Above Ground
Motion Picture by Western Electric Co.

Substitute Materials
by Speaker from Bell Telephone Laboratories

Tuesday, October 13

9:30 A.M. — Second Technical Session
HOTEL CARTER

Reducing Accidents in Wire and Wire Products Operations
by *R. H. Ferguson*, Republic Steel Corp.

Scheduling and Planning the Wire Mill for War Production
by *L. D. Seymour*, Steel Co. of Canada, Ltd.

1:00 P.M. — Luncheon and Annual Meeting
HOTEL CARTER

Addresses
by *Dr. Arthur J. Culler*, the American Red Cross and *Dr. Charles Copeland Smith*, National Association of Manufacturers

Wednesday, October 14

9:45 A.M. — Third Technical Session
HOTEL CARTER

Tungsten Carbide Applications
by *A. MacKenzie*, Carboloy Co., Inc.

Trouble Shooting on Bronze and Steel Weaving Wire
by *L. D. Granger*, Wickwire Spencer Steel Co.

Welding Electrodes
by *John W. Miller*, Reid-Avery Co.

2:00 P.M. — Mordica Memorial Lecture
HOTEL CARTER

Steel and Wire
by *Louis H. Winkler*, Bethlehem Steel Co.

7:30 P.M. — Annual Dinner and Stag Smoker
HOTEL CARTER

Thursday, October 15

9:45 A.M. — Fourth Technical Session
HOTEL CARTER

Submerged Combustion Takes Its Place in the War Industries
by *Walter G. See*, Submerged Combustion Co. of America

Electric Patenting of Wire
by *John P. Zur*, Trauwood Engineering Co.

1:30 P.M. — Plant Inspection
Electric Patenting of Wire

John Smith (HERE AND ABRO

JOHANN SCHMIDT, *German*

War . . . well, it hasn't affected my job or way of living as much as you might think. Of course, I am working longer hours, getting less to eat, but all in all, there has been no drastic change in my way of life. I've never had much freedom.

Sometimes I wonder about my cousin who emigrated to the United States several years ago and became an American citizen. I used to get wonderful letters from him, but once during a routine check-up, the Gestapo found one of these letters. Since then I have had no more letters from America.

I say my job hasn't changed so much as you might think. The government for a long, long time has told me where I must work, what job I must do, what hours I must work, what wages—such as they are—I must accept. In general, I don't have to think. Everything is planned by the government.

I don't have to think who to vote for—there are no elections. I don't have to worry about gasoline and tires, since I've never had an automobile anyway.

My working hours are from sunup to sundown—every day. If the guards *even think* I'm not working my hardest, I'll be fined or sent to prison. Ersatz foods and 10 ounces of meat a week leave me always hungry.

The Fuehrer says we are the master race and will rule the world. Yet I can't say where and how my children should be educated. I have no choice as to how I can worship. We have a state religion—a religion which glorifies the state, doesn't stress the development of the individual as in the teachings of Jesus Christ.

I have a radio, but there's a card on it constantly reminding me that if I am caught listening to any foreign broadcast, I will be subject to a heavy fine, imprisonment, or even the death penalty.

Almost all of my family's clothes and blankets were collected during the winter relief drive. This was bad, because we had no coal in the house. Neither do we have anything left in our house that can possibly be melted up or otherwise converted to the war effort.

The responsibility of winning or losing this war is not mine. I can do—*I must do*—only as I am told to do. I have no choice.

Talks About His Job—

JOHN SMITH, American

I'm Johann Schmidt's American cousin. Here in this country I have enjoyed freedoms undreamed of by Johann in Nazi Germany. Now I must fight for these freedoms I have been so happy to have. The responsibility for winning or losing this war is *mine*—mine and that of all the other American John Smiths.

I have been *asked* to make sacrifices. I know I won't be liquidated as I would be in Germany if I don't do as I am asked. But I want to co-operate. I know I must help win this war to survive. This is a fight between the Nazi system and me!

I'm free to work at the job of my choice, and to bargain for hours of labor and wage rates but I am more concerned in doing the production job that will smash Hitler and Hirohito.

I'm giving the officials of the government all the co-operation I can, but I'm free, if enough others think as I do at the time, to kick them out if I think they're not doing the right kind of a job. How I use up my tires and gasoline is up to me, but I'm saving both by taking turns with my neighbors in driving to work.

My wife turns out meals that millions of people in other countries would give a week's pay to eat. Yet I'm economizing on the family budget every week.

I can see to it that my kids are taught the things they should be taught: that when they get in high school, they can select the courses and subjects they want to study—and from textbooks written by scholars, not politicians. I can go to whatever church I please.

I can listen to any radio program on the dial, here and abroad. No one would hurt me if I criticized those who are doing their best to help win the war, but I'd rather talk patriotically, do what I can to boost morale.

Yes, I'm free to do or not to do all these things, but that very freedom places great responsibilities on me. That's why I'm investing more than 10 per cent of my pay in War Savings Bonds. I'm cutting down on buying luxuries. My wife is saving tin cans, rubber, and other scrap for salvage. We don't have to do these things, but I'm thinking of tomorrow, and any sacrifice I make today will make a better tomorrow for my family and me.

To sum up, no one is forcing me to help win this war. It's up to me. But if I wasn't doing my part I'd feel like a first-class heel. The responsibility rests *on me alone*.

Courtesy General Electric's *Commentator*

War Production Exhibitors

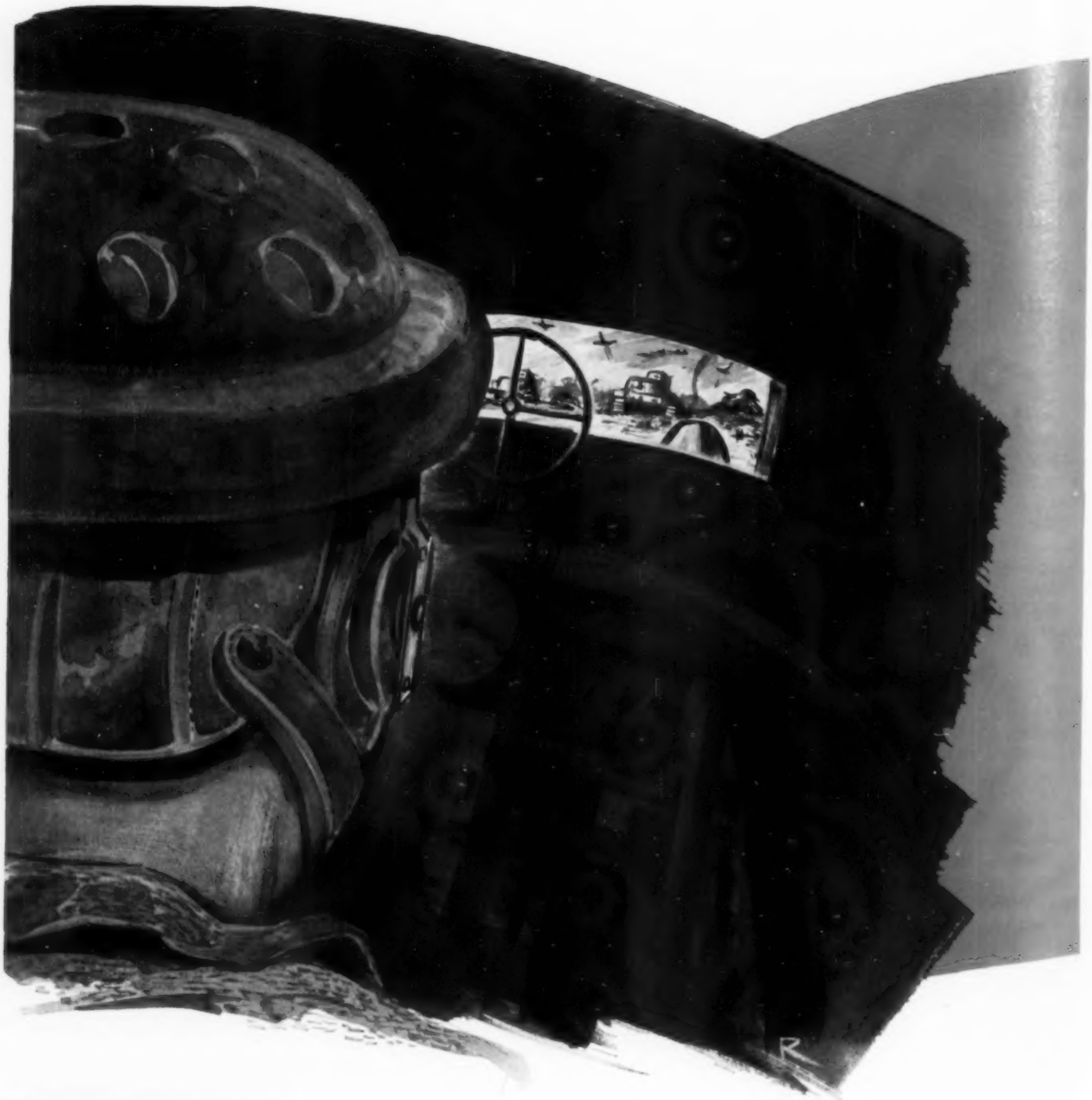
Acme Electric Welding Co., *Space A-500*
Advance Polishing Wheels, Inc., *Space E-113*
Agfa Ansco Div., General Aniline & Film Corp., *Space C-238*
Alloy Casting Co., *Space B-502*
Alox Corp., *Space B-516*
Aluminum Co. of America, *Space C-421*
Alvey Ferguson Co., *Space S-162*
American Brake Shoe & Foundry Co., *Space A-525* and *B-320*
American Brass Co., *Space A-321*
American Car & Foundry Co., *Space B-314*
American Foundry Equipment Co., *Space D-340*
American Gas Furnace Co., *Space B-103*
American Institute of Mining & Metallurgical Engineers, *Space B-508*
American Machine & Metals Co.; Riehle Testing Machine Division, *Space A-418*
American Machinist, *Space E-137*
American Manganese Steel Division, American Brake Shoe & Foundry Co., *Space A-525*
American Metal Market, *Space D-319*
American Photocopy Equipment Co., *Space C-207*
American Society for Metals, *Space D-224*
American Welding Society, *Space A-427*
Ampco Metal, Inc., *Space B-131*
Anderson & Brown Co., *Space B-137*
Anderson & Sons, *Space B-421*
Andresen, Inc., *Space B-210*
Armstrong Cork Co., *Space D-138*
Atkins & Co., E. C., *Space D-220*
Atlas Foundry Co., *Space B-320*
Atlas Publishing Co., *Space C-229*
Atlas Steels, Ltd., *Space D-113*
Automatic Gas Flux Mfg. Co., *Space D-221*
Automotive Industries, *Space C-203*
Babcock & Wilcox Co., *Space C-325*
Baker & Co., Inc., *Space B-415*
Banner Iron Works, *Space B-320*
Barnett Foundry & Machine Co., *Space B-320*
Barrett-Cravens Co., *Space C-210*
Bastian-Blessing Co., *Space C-131*
Bausch & Lomb Optical Co., *Space D-150*
Behr-Manning Co., *Space C-141*
Black Drill Co., *Space D-146*
Brickseal Refractory Co., *Space A-509*
Bridgeport Brass Co., *Space D-411*
Bruning Co., Inc., Charles, *Space A-411*
Brush Development Co., The, *Space B-142*
Buckeye Garment Rental Co., The, *Space B-419*
Buehler, A. I., *Space E-111*
Butterworth & Sons, *Space B-320*

Cambridge Wire Cloth Co., *Space C-217*
Canadian Radium & Uranium Corp., *Space S-130*
Carboloy Co., Inc., *Space B-324*
Carborundum Co., The, *Space C-122*
Catskill Metal Works, Inc., *Space A-514*
Chase Brass & Copper Co., *Space B-327*
Chemical Rubber Co., *Space B-520*
Chicago Flexible Shaft Co., Stewart Industrial Furnace Division, *Space E-114*
Chicago Steel Foundry Co., *Space L-102*
Chromium Mining & Smelting Corp., Ltd., *Space C-211*
Cinaudagraph Corp., *Space B-425*
City Engineering Co., *Space D-310*
Cleveland Graphite Bronze Co., *Space C-322*
Cleveland Ordnance District, War Department, *Spaces B-212, C-214* and *C-218*
Cleveland Overall Co., *Space B-419*
Cleveland Tapping Machine Co., *Space A-309*
Climax Molybdenum Co., *Space A-501*
Commerce Pattern Foundry & Machine Co., *Space B-424*
Continental Industrial Engineers, *Space C-133*
Cramer Co., R. W., *Space C-424*
Crescent Machine Co., *Space B-335*
Crown Rheostat & Supply Co., *Space A-310*
Darwin & Milner, Inc., *Space C-118*
Deepfreeze Division, Motor Products Co., *Space A-401*
Delaware Tool Steel Corp., *Space A-325*
De Sanno & Son, Inc., A. P., *Space B-431*
Despatch Oven Co., *Space A-415*
Detecto Scales, Inc., *Space C-232*
Detroit Rex Products Co., *Space D-311*
De Walt Products Corp., *Space D-203*
Dietert Co., Harry W., *Space A-410*
DoAll Cleveland Co., Inc., *Space B-141*
Dow Chemical Co., *Space B-111*
Drop Forging Asso., *Space C-227*
Du Pont de Nemours & Co., E. I., *Space D-134*
Duraloy Co., *Space B-110*
Eastman Kodak Co., *Space A-318*
Eby, Hyatt, *Space B-511*
Eisler Engineering Co., *Space A-500*
Elastic Stop Nut Corp., *Space A-424*
Electro Refractories & Alloys, *Space D-315*

Electroloy Co., Inc., *Space A-500*
Eutectic Welding Alloys, Inc., *Space E-140*
Executone Systems, *Space D-209*
Experimental Tool & Die Co., *Space B-511*
Expert Welding Machine Co., Inc., *Space A-500*
Farrel-Birmingham Co., *Space B-320*
Federal Machine & Welder Co., *Space A-500*
Federal Products Corp., *Space B-401*
Firth-Sterling Steel Co., *Space C-150*
Florence Pipe Foundry & Machine Co., *Space B-320*
Ford Co., J. B., *Space C-117*
Fulton Foundry & Machine Co., *Space B-320*
General Alloys Co., *Space C-146*
General Electric Co., Tungar & Copper Oxide Rectifier Div., *Space C-215*
General Electric X-Ray Corp., *Space D-130*
General Foundry & Mfg. Co., *Space B-320*
Globar Division, Carborundum Co., *Space C-122*
Globe Machine & Stamping Co., *Space B-335*
Gordon Co. of Ohio, Claud S., *Space E-102*
Gray Machine Co., *Space S-124*
Gray-Mills Co., Inc., *Space B-418*
Great Lakes Steel Corp., *Space S-150*
Greenlee Foundry Co., *Space B-320*
Gulf Oil Co., *Space A-329*
H. & H. Research Co., *Space C-242*
Hamilton Foundry & Machine Co., *B-320*
Hamilton Tool Co., *Space D-310*
Hammond Machinery Builders, Inc., *Space D-122*
Handy & Harman, *Space D-314*
Heat Treating & Forging, *Space B-514*
Heil Engineering Co., *Space A-332*
Hevi Duty Electric Co., *Space D-142*
Hild Floor Machine Co., *Space C-324*
Hitchcock Publishing Co., *Space A-314*
Holcroft & Co., *Space D-306*
Holden Co., A. F., *Space B-147*
Holliday & Co., W. J., *Space C-315*
Houghton & Co., E. F., *Space D-137*
Howe & Son, Inc., *Space C-234*
Illinois Testing Laboratories, Inc., *Space E-133*
Independent Pneumatic Tool Co., *Space C-314*
Induction Heating Corp., *Space B-328*

National Metal Exposition

Industrial Publishing Co., Space A-416
Instrument Specialties Co., Inc., Space C-335
International Nickel Co., Space C-111
Iron Age, The, Space B-121
Johnson & Son, S. C., Space C-230
Jones Co., C. Walker, Space B-524
Kalamazoo Tank & Silo Co., Space D-218
Kanawha Mfg. Co., Space B-320
Kelley Co., The J. W., Space C-336
Kelley-Koett Mfg. Co., Space D-114
King, Andrew, Space B-118
Kinney Iron Works, Space B-320
Koehring Co., Space B-320
Kold-Hold Mfg. Co., Space E-130
Krouse Testing Machine Co., Space C-420
Lake City Malleable Co., The, Space C-219
Latrobe Electric Steel Co., Space D-225
Lepel High Frequency Laboratories, Space D-328
Lester-Phoenix, Inc., Space A-341
Lindberg Engineering Co., Space B-146
Lukens Steel Co., Space C-340
Machinery, Space E-122
Machinery Mfg. Co., Space D-335
Magnaflux Corp., Space A-320
Magnetic Analysis Corp., Space D-327
Mahr Manufacturing Co., Space D-418
Mall Tool Co., Space D-321
Mallory & Co., Inc., P. R., Space A-500
Manhattan Rubber Mfg. Co., Space D-323
Marquette Mfg. Co., Space A-315
Martindale Electric Co., The, Space B-114
Matchless Metal Polish Co., Space E-113
McCann Furnace Co., Space C-222
McKenna Metals Co., Space C-110
Meehanite Research Institute of America, Space B-320
Metal Industry Publishing Co., Space B-526
Metallizing Co. of America, Space D-207
Metallizing Engineering Co., Space C-225
Metal Progress, Space D-224
Metals & Alloys, Space A-513
Metlab Co., Space D-215
Mill & Factory, Space L-103
Minnesota Mining & Mfg. Co., Space B-340
Model Tool Mfg. Co., Space C-242
Modern Machine Shop, Space C-431
Molybdenum Corp. of America, Space D-111
Morrison Engineering Co., Space A-414
Morse Magneto Clock Co., Space A-511
Multi-Hydromatic Welding & Mfg. Co., Space A-500
National Electric Welding Machine Co., Space A-500
National Industrial Publishing Co., Space D-325
National Machine Works, Space B-130
National Machinery Co., Space A-335
National Refining Co., Space A-420
Niagara Blower Co., Space C-428
Nicholson File Co., Space C-320
Norton Company, Space C-138
Oakite Products, Inc., Space E-134
Ohio Carbon Co., Space C-328
Ohio Crankshaft Co., Space A-324
Ohio Seamless Tube Co., Space D-110
Ohio Steel Foundry, Space D-213
Osborn Mfg. Co., Space B-427
Pangborn Corp., Space C-130
Park Chemical Co., Space S-112
Parker-Kalon Corp., Space B-134
Penton Publishing Co., Space E-143
Perkins Co., Henry, Space B-320
Philips Metalix Corp., Space B-337
Phillips Mfg. Co., Space C-327
Picker X-Ray Corp., Space B-122
Pittsburgh Pipe Cleaner Co., Space A-431
Pohlman Foundry Co., Space B-320
Porter-Cable Machine Co., Space A-519
Precise Tool & Mfg. Co., Space A-311
Progressive Welder Co., Space A-500 and A-340
Radium Chemical Co., Space B-504
Ransohoff, Inc., N., Space B-311
Ransome Machinery Co., Space B-102
Reeves Pulley Co., Space A-419
Resistance Welders Mfrs. Association, Space A-500
Revere Copper & Brass Co., Space B-306
Richards Co., J. A., Space D-210
Rolock, Inc., Space S-132
Rosedale Foundry & Machine Co., Space B-320
Ross-Meehan Foundries, Space B-320
Rustless Iron & Steel Corp., Space C-102
Safety Socket Screw Corp., Space C-226
Scherr & Co., George, Space E-110
Schrader's Son, A., Space D-410
Sciaky Bros., Space A-518
Selas Co., The, Space D-102
Sentry Co., The, Space B-411
S-M-S Corp., Space A-500
Solventol Chemical Products, Inc., Space D-223
Sparkler Mfg. Co., Space A-523
Spencer Turbine Co., Space E-141
Sperry Products, Inc., Space A-306
Standard Machinery Co., Space A-421
Standard Oil Co. (Ohio), Space D-336
Standard X-Ray Machine Co., Space A-429
Stearns-Rogers Mfg. Co., Space B-320
Sterling Alloys, Inc., Space B-115
Stuart Oil Co., Ltd., D. A., Space C-310
Super Tools Co., Space D-222
Surface Combustion, Space D-118
Swift Electric Welder Co., Space A-500
Tagliabue Mfg. Co., Space S-126
Taylor-Hall Welding Corp., Space A-500
Taylor Winfield Corp., Space A-500
Tel Autograph Corp., Space C-233
Tempil Corp., Space B-138
Tennant Co., G. H., Space S-110
Thomson-Gibb Electric Welding Co., Space A-500
Tide Water Associated Oil Co., Space D-324
Tinnerman Products, Space D-414
Titanium Alloy Mfg. Co., Space A-336
Trent Co., Harold E., Space A-405
Trico Products Corp., Space D-211
Triplex Machine Tool Co., Space D-310
Ultra-Lap Machine Co., Space D-310
Union Steel Products Co., Space D-219
United States Stoneware Co., Space D-212
Valley Iron Works, Space B-320
Vanadium Corp. of America, Space A-510
Vascoloy-Ramet Corp., Space A-504
Victor Saw Works, Space A-328
Vulcan Corp., Space D-217
Vulcan Foundry Co., Space B-320
Wall Colmonoy Corp., Space B-339
Warren Foundry & Pipe Corp., Space B-320
Welding Engineer, Space S-158
Welding Machines Mfg. Co., Space A-500
Welding Sales & Engineering Co., Space A-500
Wellman Co., The S. K., Space E-142
Wells Mfg. Corp., Space B-310
Westinghouse Electric & Mfg. Co., Space B-405
Wilson Mechanical Instrument Co., Space C-137
Wire Association, Space A-425
Youngstown Service Products Co., Space C-208



PURCHASING

COMPARE the unique Arcos production facilities and you'll see why Chromang shipping promises are being met. The entire Arcos plant is practically 100% on stainless electrodes — we have no other electrode lines to divert our energies. Over a year ago Arcos set in motion the expansion program which is now at its peak.

Chromang mets every requirement for a quality armor welding electrode. It's a good buy — ballistically, metallurgically, practically, and economically. Only Arcos makes Chromang — and Arcos keeps its shipping promises.

Regularly produced are all sizes from 1/8" to 5/16" diameter. All diameters are 14" long, end grip, except 5/16", which is 18" long, end grip.

BUFFALO, N. Y. – *Root, Neal & Co.* • BORGER, TEXAS – *Hart Industrial Supply Co.* • BOSTON, MASS. (Belmont) – *H. Boker & Co., Inc.; W. E. Fluke* • CHICAGO, ILL. – *Machinery & Welder Corp.* • CINCINNATI, OHIO – *Williams & Co., Inc.* • CLEVELAND, OHIO – *Williams & Co., Inc.* • COLUMBUS, OHIO – *Williams & Co., Inc.* • DETROIT, MICH. – *C. E. Phillips & Co., Inc.* • ERIE, PA. – *Boyd Welding Co.* FRESNO, CALIF. – *Victor Equipment Co.* • FT. WAYNE, IND. – *Wayne Welding Supply Co., Inc.* HONOLULU, HAWAII – *Hawaiian Gas Products, Ltd.* • HOUSTON, TEXAS – *Champion Rivet Co. of Texas* • KANSAS CITY, MO. – *Welders Supply & Repair Co.*

Production of

.50 CALIBER BROWNING

Machine Guns

AHEAD OF SCHEDULE

Metallurgists say:

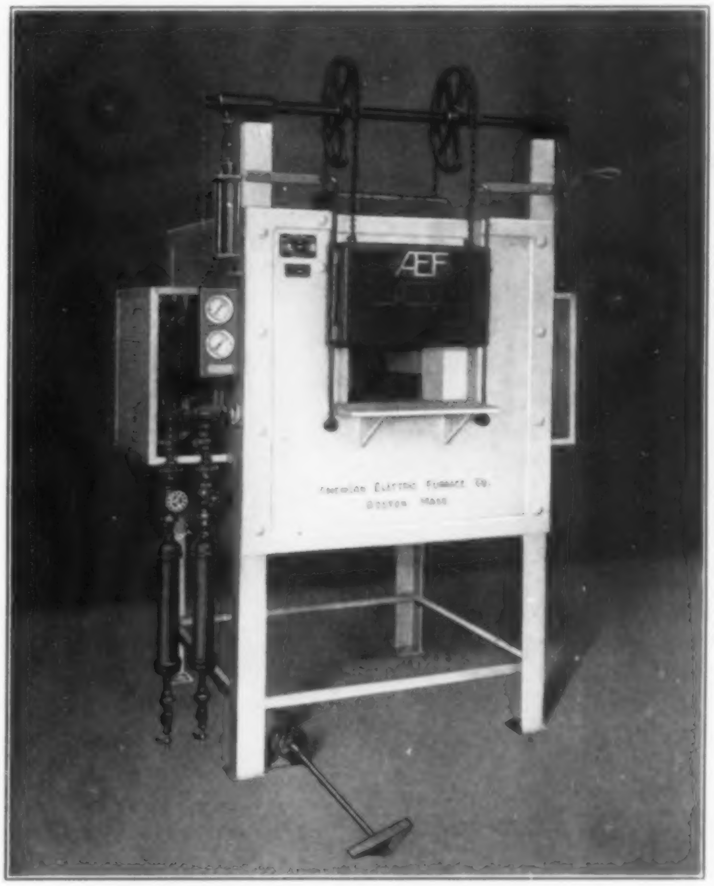
"More finished guns per tool."

Resulting from the use of "AMERICAN" ELECTRIC FURNACES for hardening high speed tools.

Use modern equipment for present day production schedules.

Buy "AMERICAN"

Write for prices.



Model HB1218 with "AMERICAN"

Synchronized Atmospheric Control. Work Chamber 12" wide x 18" deep x 8" high. Rating 33K.W.

AEF

American Electric Furnace Company

30 VON HILLERN ST. ★ BOSTON, MASS., U. S. A.

Industrial Furnaces for All Purposes

Personals

Harold E. Koch, vice-president of the Hevi Duty Electric Co., Milwaukee, has been named president succeeding the late **Edwin L. Smalley**. **George A. Chutter**, eastern district manager, and **Norman C. Bloye**, sales engineering department, have been named vice-presidents.

R. E. Neils, chairman of the Oregon Chapter, has left the employ of the U. S. Forest Service and is now with the Schmitt Steel Co. of Portland, in engineering and production work.

Hiland G. Batcheller, president of Allegheny Ludlum Steel Corp. of Pittsburgh, has been appointed head of the Iron and Steel Branch of War Production Board, succeeding Reese H. Taylor who resigned on Aug. 31.

Charles Lee Clayton has resigned his position with Columbia Steel Co. at Los Angeles, and is now research engineer in metallurgical engineering with Vultee Aircraft at Downey, Calif.

James F. Bacon is now employed as a research associate of the Underwater Sound Laboratory of Harvard University.

Milton Stoll, formerly technologist and metallurgist of the New England Smelting Works, West Springfield, Mass., is now chief inspector and metallurgist of the Allen D. Cardwell Mfg. Corp., Brooklyn, N. Y.

Edward A. Kachik is now employed as a metallurgist at the Experimental Station of the E. I. du Pont de Nemours and Co., Inc., Wilmington, Del.

Lieut. Harold G. Bowen, Jr. is now assistant to inspector for materials at the Washington Navy Yard.

Transferred by Republic Steel Corp.: **Leon H. Nelson**, from assistant open-hearth superintendent, Buffalo plant, to electric furnace metallurgist, Chicago plant.

Kurt R. Gustafson is now supervisor of the melting room of the Extruded Metals Defense Corp., Grand Rapids, Mich.

Gilbert Cutton is now metallurgical assistant at Carnegie-Illinois Steel Corp., Youngstown, Ohio.

Jesse O. Betterton, Jr. is now working in the metallurgical department of the Dow Chemical Co. on rolling and forming of magnesium alloys.

J. H. LoPrete has left the bearing division of Bohn Aluminum and Brass Corp. where he was assistant metallurgist, to take charge of the laboratories for Wolverine Tube Division of Calumet and Hecla Consolidated Copper Co., Detroit.

…E FOOTSTEPS OF GENERAL ALLOYS MARK THE PATH OF AN INDUSTR…

GA X-ITE GA Q-ALLOYS GA X-ITE GA Q-ALLOYS

JOHN WYZALEK

ARTHUR PAINTER

…THUR PAINTER, General Alloys Company's New York Office Manager, died from heart … Friday, August 14th. The last communication we received from "Art" was a carbon … of a letter of condolence written by him to friends at Hyatt Roller Bearings Company, … the death of his friend and ours, John Wyzalek. On the bottom of the carbon copy …" had penned "Heart Attack." "Art" Painter had had a previous siege in the hos-… He was under doctor's orders, but "Art", like John, was giving his **BEST**, night and … to U. S. WAR PRODUCTION, and "to hell with the consequences." These men, and … like them, are true war casualties in the management group that is carrying the … plotting the course, and taking the abuse.

…OYALTY, Mentality, Vitality"—have long been our measure of men, and to this stand-… "Art" Painter stood out among men. With the sudden and all-engulfing demands … upon us in up-surge of the war effort, "Art" and many of his customers got "kicked …" on deliveries. **NEVER DID ART GRIPE!** In his years of association with General … "Art" Painter never sought an advantage, price or personal.

…a strike he pitched into the shop, able foundryman that he was, and sought extra burden … himself, an inspiration to all. But, "Art's" greatest pride, the only accomplishment he … mentioned, was his family. Many men of great accomplishment in industry can well … the "Job" Art Painter delivered as head of a real American family. After his services … the cemetery many of his friends returned to the house, for a drink and a snack, … old times, and a toast to "Art". "Art wouldn't let you boys run out without a drink … a laugh", said Mrs. Painter, "and we must carry on."

…NY men and women gathered together to pay homage to "Art" Painter, for many had … the warmth of his friendship, had known the aid of his keen engineering mind, and … loyalty of his outstanding manhood. All of them left that day with the word or thought "On families like Arthur Painter's rests the future of America—and that future is secure."

…RLY in my engineering career I had the privilege of making a survey of the Heat Treat-… Departments of all General Motors Corporation plants. At Hyatt I worked with John …lek, learned much from him. John was one of a small group … outstanding American metallurgists, who led the infant automobile …stry from the blacksmithing stage into the era of modern metal-…, always blazing new trails, years ahead of the textbooks. When … VICTORY is won, the name of **JOHN WYZALEK** will rank high … Men of Metals who forged the **TOOLS of VICTORY**.

…TH respect to our labor trouble, which we had before the National … Labor Board, we feel that this company got fair and reasonable …ment. We want particularly to express our appreciation of the … that Mr. Louis A. Lopez of the Pressmen's Union, who was the La-… member of our panel, dealt with us frankly and fairly as a …ghtforward American and indulged in none of the chicanery, …, misrepresentation, and generally shady and stupid practice … we have heretofore encountered in our relations with organized …, and far too many government and state officials. Many of … latter, who have been trying to serve labor against the nation's … cost, have been in the position of Jocko, the monkey, fiancé of …, the giraffe. Between tying a ribbon on Minnie's tail and …ing up her neck to kiss her, Jocko is all worn out. Most of the … politicians are suffering from flag strain, which comes from …ing onto the labor vote with both hands and still trying to wave … flag.

…HEN we were called to Washington on a phony strike we thought … were headed for a political labor frameup. We encountered three … men. Our panel was—Dean W. T. Van Hecke, Mr. S. L. Thom-… and Mr. Louis A. Lopez. Justice is sometimes obtainable if you … put up with terrific abuse and fight like hell. General Alloys will … all the apprentices it needs without interference.

…CK to school goes the generation of tomorrow. Many Americans … fought and died that they, through us, might inherit and per-…ate "The American Way of Life."

…NY of their fathers and most of their brothers are facing cold … and vicious fire for them and for all we hold dear. Their future … free men and women depends upon us, and most vitally on what … in the immediate, IMMEDIATE, **IMMEDIATE FUTURE**, today, …rrow and in those days of trial upon us.

…HAT are we fighting for? Everything that is worth living for, and … all of us—soldiers, workers, farmers and management—can look … kids in the eye and say "We are giving all for victory" we will …idually deserve anything that befalls us, but how about them?

… want to thank our young friends for the many splendid letters … in for "Adolph-The-Pig" bank that squeals every time you put … in it. We have another 100 banks for children of A.S.M. mem-… who write in as per our ad in August Metal Progress.

F. B. Harris

Q-ALLOYS THE QUALITY NAMES IN ALLOY FOR HEAT CORROSION ABRASION X-ite

Personals

Major F. H. Holmes ⊕, previously chief inspector of ordnance materials, Pittsburgh district, British Ministry of Supply Mission, has been called to active duty with the U. S. Army Air Corps as base ordnance officer, Boca Raton Field, Fla.

D. A. Sherick ⊕, formerly of the Weirton Steel Co., Weirton, W. Va., has joined the metallurgical staff of the Babcock & Wilcox Tube Co., as production metallurgist of the welded tube division, Alliance, Ohio plant. **M. L. Samuels** ⊕, formerly of Battelle Memorial Institute, has also joined Babcock & Wilcox Tube Co., Beaver Falls, Pa., as research metallurgist.

Martin H. Schmid ⊕, manager of the alloys division of Republic Steel Corp., Massillon, Ohio, has been elected chairman of the Armament Steels and Alloys Advisory Committee, Office of Price Administration.

Glenn H. Wells ⊕ has been transferred to the Schenectady plant of the American Locomotive Co.

William M. Jung ⊕ has been promoted from assistant metallurgist to metallurgist, Sperry Gyroscope Co., Brooklyn, N. Y.

Gordon McMillin ⊕, formerly chief metallurgist, Standard Brake Shoe & Foundry Co., Pine Bluff, Ark., is now metallurgist for General Steel Castings Corp., Armor Plant, Madison, Ill.

W. J. Dysert ⊕, formerly with Cadillac Motor Car Co., is now contact metallurgist for the Chrysler Corp., Detroit.

Lieut. William A. Bumgardner ⊕, formerly a partner in Bumgardner and Co., Warwood, West Va., is now stationed at Fort Belvoir, Va. as an instructor.

John W. Mitchell, president, **C. M. Bradford** ⊕, vice-president, and **A. J. Mitchell** ⊕, secretary-treasurer, the Mitchell-Bradford Chemical Co., Bridgeport, Conn., have leased larger quarters for office and laboratory in Stratford, Conn., the manufacturing division remaining in Bridgeport.

Robert T. Woodbury ⊕, formerly testing and bundling department foreman, has been appointed general metallurgist for the New Haven and Trenton Works, American Steel & Wire Co.

Paul Bishop ⊕ is now chief inspector, Cleveland division, the Glenn L. Martin Co.

Promoted: **R. P. Burris** ⊕ to assistant to manager of sales, Boston district, Carnegie-Illinois Steel Corp.

The *right brass* for the job

YOUR
Jim Brown

OUR
Bill Smith

The problems of *your* Jim Browns and *our* Bill Smiths may be the same

YOUR men and ours are putting their all into the battle for greater production. Their knowledge of brass and its war requirements is helping to win the fight for freedom.

Perhaps your problems and ours are fundamentally the same. If yours involve deep draws in brass, special degrees of softness or hardness, or extremely close tolerances, we will gladly give you the benefit of our long experience in specifying the right brass for your job.

Western-operated ammunition plants are making millions of deep drawn parts *daily* out of Western brass. The metal in each cartridge case must possess the right ductility, and the correct tensile strength to draw without rupture.

We invite consultation on your brass requirements for present and post-war products.

Western
BRASS
PRODUCTS
WESTERN CARTRIDGE COMPANY
EAST ALTON ILLINOIS U.S.A.

BRASS MILL DIVISION

Western Cartridge Company

East Alton, Illinois

BRASS • BRONZE • PHOSPHOR BRONZE • NICKEL SILVER

Personals

William C. Schulte, formerly associate professor of mechanical engineering in charge of metallurgical courses at Rutgers University, New Brunswick, N. J., is now chief metallurgist of the New Jersey plant of Curtiss Propeller Division, Curtiss-Wright Corp., Caldwell, N. J.

Promoted: **Charles W. MacGregor**, to full professorship at Massachusetts Institute of Technology, and placed in charge of the materials division of the mechanical engineering department.

R. R. Hershey, formerly with the steel and tube division of the Timken Roller Bearing Co. at Cleveland, has assumed duties as ensign in the Naval Ordnance Department in Columbus, Ohio.

Daniel W. Talbott has been made plant superintendent, Lima South plant, Ohio Steel Foundry Co., Lima, Ohio.

Ernest R. Carr has resigned as metallurgist and tool engineer for Oliver Iron & Steel Corp. to become process control metallurgist, Remington Arms Co., Inc., Bridgeport, Conn.

W. J. Reagan, past chairman, Pittsburgh Chapter and previously assistant superintendent, Edgewater Steel Co., Oakmont, Pa., has been appointed melt shop research metallurgist with the Copperweld Steel Co. in Warren, Ohio.

George B. Waterhouse, past national president, has been transferred from the War Production Board to the Office of Lend-Lease Administration, as special consultant to the Administration on metal problems, particularly iron and steel.

Promoted to lieutenant colonel: **Alfred W. Sikes**, C.W.S., now chemical officer of the 89th Division, Camp Carson, Colo.

F. Lloyd Woodside, formerly with the metallurgical research division of the Climax Molybdenum Co., has become president of the Park Chemical Co., Detroit, succeeding his brother, **William Park Woodside**, now chairman of the board.

M. J. Donachie, past secretary, Springfield Chapter, and formerly with George W. Prentiss & Co., Holyoke, Mass., is now connected with the Beryllium Corp. of Pennsylvania, Reading, Pa.

M. Sarullo has left American Bosch Magneto, Springfield, Mass. to do war inspection work at De Laval Separator Co., Poughkeepsie, N. Y.

Henry J. Becker has left Goodyear Aircraft to take an appointment as tool and product manager of Air Associates, Inc., Los Angeles.

New Equipment and Products

Steel Handbook

Bliss & Laughlin, Inc., has published a 228-page handbook for steel users, a storehouse of reference information on cold finished bar steels, describing not only the methods of production, but containing a large number of tables useful to the design engineer, machine operator and metallurgist, much of which is original material accumulated during the firm's 50-year life.

If you are interested in cold finished steels, write to Bliss & Laughlin, Inc., Harvey, Ill., and make arrangements to have this book on your reference shelf.

Hild Vacuum

One of the principal makers of plant maintenance equipment, the Hild Floor Machine Co., Chicago, has developed the Hild Vacuum for draining cutting oil out of the reservoir when it needs to be changed or reclaimed. Full information may be obtained from the Hild display at the Metal Exposition, space C-324.

Aluminum Heat Treating

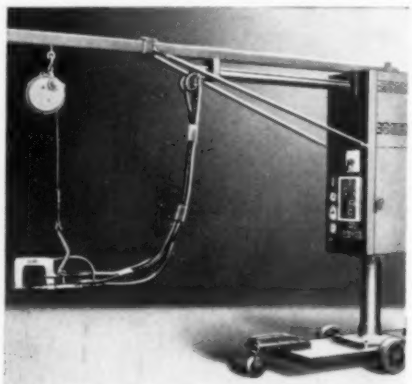
Despatch Oven Co., Minneapolis, has installed an aluminum heat treating furnace in a Cincinnati plant. Believed to be the first of its kind, this furnace is capable of quenching 8000 lb. of castings in 25 sec. Secret of its fast production, apart from the furnace proper, rests with the improved material handling. Photograph is reproduced below.

Industrial Film

New and faster fine-grain industrial film is announced by the Photo Products Dept. of Du Pont Co., Wilmington, Del. Because of its added speed, "Type 506 Fine-Grain" should produce radiographs of the lighter metals with excellent detail and contrast, with shorter exposures.

Radial Spot Welder

Sciaky Brothers, now operating in their modern plant at 4915 W. 67th Street, Chicago, are offering a radial-type gun spot welder, P-1-R, in both stationary and buggy-mounted units. The gantry unit illustrated has a 15-ft. arm. Equipped with a special Sciaky welding timer and operating on single phase alternating current,



220 or 440 volts, this welder handles corrosion resisting steel, pickled steel, zinc coated steel and monel metal in thicknesses up to 0.064 in. Speed of 180 spot welds per minute can be attained when joining two 0.032-in. sheets.

Automatic Arc Welding

Complete equipment for automatic arc welding with heavily coated electrodes in cut lengths has been announced by the General Electric Co., Schenectady, N. Y. Equipment is particularly suited to work where one or more complete joints can be made with a single electrode, such as in the welding of shells, wheels, and tubular assemblies where the starting and finishing ends of a single weld bead overlap.

New Babbitt Metal

With the shortage of tin and government restrictions, National Bearing Metals Corp., St. Louis, has developed a new tin-saving "Rex" bearing metal with a minimum sacrifice of tensile and compressive strengths — a creditable substitute for babbitt, for most present uses, if properly applied, carefully fitted and lubricated.

Quench Oil Strainer

New oil strainer, specifically designed for quenching oil, is

(Continued on page 522-P)

Today TENUAL ALUMINUM CASTINGS are going to war!
Tomorrow when the Victory is won...
our foundries will be ready to turn out quality sand and permanent mold aluminum castings with the same precision and speed for your peacetime needs.
And, then, as now, into every casting will go the invaluable experience and skill of our workmen plus the constant research of our technical engineers.
THE National BRONZE & ALUMINUM FOUNDRY CO.
Twin Plants, CLEVELAND, OHIO
NEW YORK, 111 Broadway • CHICAGO, 188 W. Randolph • DETROIT, Stephenson Bldg. • LOS ANGELES, 405 S. Hill
MAKERS OF QUALITY SAND AND PERMANENT MOLD ALUMINUM CASTINGS

New Products

(Continued from page 522-N)

offered by Bell & Gossett Co., Chicago. Two basic features permit thorough cleaning of the oil without restricting free flow. First, it is ample in size to accumulate large amounts of scale; second, screens are meshed to meet various operating conditions without clogging, yet afford full protection to the pump.

Steel Cartridge Anneal

Interesting story in the September issue of *Ajax Metelectric Progress,* published by Affiliated Ajax Companies, 46 Richmond St., Philadelphia, describes two necessary annealing processes for steel artillery ammunition. Coordinated in mass production with the Ajax-Hultgren salt bath furnaces, the largest manufacturers of steel cartridge cases have adopted these furnaces as standard for mouth and taper anneal.

New Alloy Sprayer

Inexpensive, self contained, and portable metal atomizer, capable of spraying any neutral

alloy below 600° F., and useful for protective coatings or reproducing likenesses, is offered by Alloy-Sprayer Co., 2040 Book Bldg., Detroit.

It is recommended for making templates, spotting or checking dies, and reproducing molds. It is suitable where accuracy of reproduction is so fine that even pin scratches must be faithfully reproduced.

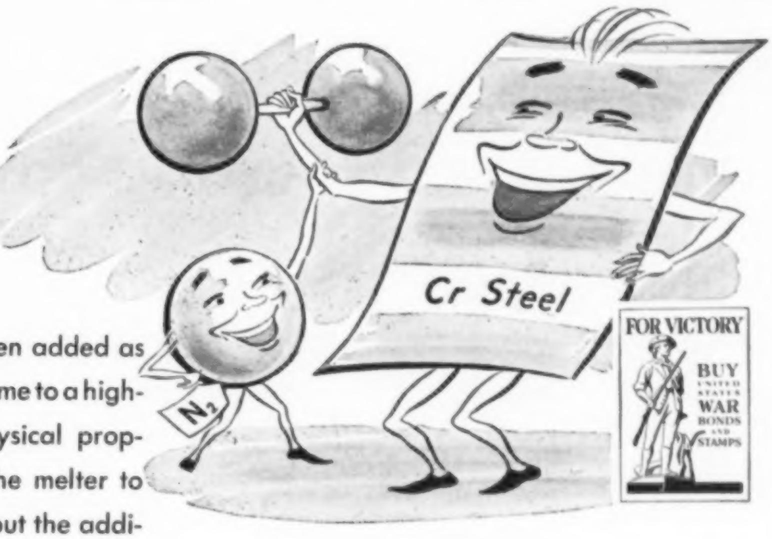
Mounted Wheels

Catalog which presents, for the first time, detailed instructions on the operation of mounted wheels and accessories for portable equipment, the Handee and Hi-Power grinders. Edited strictly along the war pattern, in an effort to meet important and rapid changes in production methods, Chicago Wheel & Mfg. Co.'s informative booklet includes a selection guide, illustrated with exact size and color.

Thurner Carbo-Cleaner

This machine for cleaning carburizing compounds is now being sold by Park Chemical Co., in the territory east of the Mississippi (except Iowa). When you attend the Metal Exposition, see it at Park's exhibit space, S-112.

Additions of NITROGEN
improve High-Chromium Steels



SMALL percentages of Nitrogen added as Nitrogen-Bearing Ferrochrome to a high-chromium steel improve the physical properties of the steel, and permit the melter to obtain desirable properties without the addition of other alloying elements.

In 12 to 14 Per Cent Chromium Low-Carbon Steels, Nitrogen acts like carbon in increasing strength and hardenability; but ductility, toughness, and corrosion resistance are retained.

In Cutlery Steels, Nitrogen gives increased hardness without the decreases in ductility, toughness, and corrosion resistance occurring when the carbon content is increased.

In Annealed 16 to 18 Per Cent Chromium Wrought Steels, Nitrogen produces an extraordinary increase in toughness.

In 20 to 30 Per Cent Chromium Steels, Nitrogen refines the grain and increases the ductility. These steels are ductile even after exposure to elevated temperatures. Small additions of nickel and Nitrogen give outstanding impact strength.

In Austenitic 18-8 Type Stainless Steel, Nitrogen gives a definite increase in yield point and tensile strength at no sacrifice in workability.

In Cast 25-12 Type Stainless Steel, Nitrogen markedly improves the residual ductility in steels that have been exposed to high temperatures, and at the same time maintains the tensile and creep strength.

For further information about Nitrogen-Bearing Ferrochrome, write on your business letterhead for this helpful booklet "Nitrogen in Chromium Alloy Steels."

Electromet
Trade Mark
Ferro-Alloys & Metals

Distributed through offices of Electro Metallurgical Sales Corporation in Birmingham, Chicago, Cleveland, Detroit, New York, Pittsburgh, and San Francisco.

ELECTRO METALLURGICAL COMPANY
Unit of Union Carbide and Carbon Corporation
30 East 42nd Street UCC **New York, N. Y.**
In Canada, Electro Metallurgical Company of Canada, Limited, Welland, Ontario.

Protection Against War Chemicals

General Information Concerning the Characteristics, Effects, and Counteraction of the Agents an Enemy Might Use in War

By Walter P. Burn, Lt. Col., C.W.S.

	Names and Symbols	Form	Odor	Physiological Effect	Tactical Class	Protection	First Aid [*After removal from gassed area*]	Persistence	Field Neutralization
Vesicants	Mustard $S(CH_2CH_2)_2Cl_2$ Dichlorethyl sulphide	Liquid and vapor	Garlic, mustard, horse-radish	Delayed effect. Burns skin or membrane. Inflammation of respiratory tract leading to pneumonia. Eye irritation, conjunctivitis	Hospital case	Gas mask & protective clothing	Undress; remove liquid mustard with protective ointment, bleach paste, or kerosene; bathe; wash eyes and nose with soda solution	One day to one week; longer if dry or cold	Cover with unslaked lime and earth; 3% solution of Na_2SO_3
Vesicants	Lewisite $CHClCH\text{-}AsCl_2$ Chlorvinyl-dichlorarsine	Liquid and vapor	Geraniums	Burning or irritation of eyes, nasal passages, respiratory tract, skin. Arsenical poison	Hospital case	Gas mask & protective clothing	Undress; remove liquid Lewisite with hydrogen peroxide, lye in glycerine, or kerosene; bathe; wash eyes and nose with soda. Rest and doctor	One day to one week; longer if dry or cold	Wash down with water. Cover with earth. Alcohol. NaOH spray
Vesicants / Lung irritants	Ethyldichlorarsine $C_2H_5\text{-}AsCl_2$	Liquid & vapor or gas	Stinging, like pepper in nose	Causes blisters, sores, paralysis of hands, vomiting. Severe on long exposure	Hospital case	Gas mask & protective clothing	Undress; remove liquid with hydrogen peroxide, lye in glycerine, or kerosene; bathe; wash eyes and nose with soda. Rest and doctor	One hour	Cover with earth, caustic
Lung irritants	Chlorine Cl_2	Gas	Highly pungent	Lung irritant	Hospital case	Gas mask	Remove from gassed area. Keep quiet and warm. Coffee as stimulant	10 minutes	Alkaline solution
Lung irritants	Chlorpicrin CCl_3NO_2 Nitrochloroform	Gas	Flypaper, anise	Causes severe coughing, crying and vomiting	First-aid; and hospital case	Gas mask	Wash eyes, keep quiet and warm. Do not use bandages	Open 6 hours; woods 12 hours	$NaSO_3$ — sodium sulphite in alcohol solution
Lung irritants	Diphosgene $ClCOOC\text{-}Cl_3$ Trichlormethyl chloroformate	Gas	Ensilage, acrid	Causes coughing. Breathing hurts, eyes water, toxic	Hospital case	Gas mask	Keep quiet and warm. Give coffee as a stimulant	30 minutes	Alkali
Lung irritants	Phosgene $COCl_2$ Carbonyl chloride	Gas	Musty hay, green corn	Irritation of lungs, occasional vomiting, tears in eyes, doped feeling. Occasionally symptoms delayed; later, collapse, heart failure	Hospital case	Gas mask	Keep quiet and warm; rest in bed. Coffee as a stimulant. Loosen clothing. No alcohol or cigarettes	10 to 30 minutes	Alkali
Lacrimators	Cloracetophenone $C_6H_5CO\text{-}CH_2Cl$	Gas	Apple blossoms	Makes eyes smart. Shut tightly. Tears flow. Temporary	First-aid treatment	Gas mask	Wash eyes with cold water or boric-acid solution. Do not bandage. Face wind. For skin, sodium sulphite solution	10 minutes	Strong, hot solution of sodium carbonate
Lacrimators	Brombenzylcyanide $C_6H_5CH\text{-}BrCN$	Gas	Sour fruit	Eyes smart, shut, tears flow. Effect lasts some time. Headache	First-aid treatment	Gas mask	Wash eyes with boric acid. Do not bandage	Several days; weeks in winter	Alcoholic sodium hydroxide spray
Sternutators	Adamsite $(C_6H_4)_2\text{-}NHAsCl$ Diphenylaminechlorarsine	Gas	Coal smoke	Causes sneezing, sick depressed feeling, headache	First-aid treatment	Gas mask	Keep quiet and warm. Loosen clothing. Reassure. Spray nose with neo-synephrin or sniff bleaching powder. Aspirin for headache	10 minutes	Bleaching powder solution
Sternutators	Diphenylchlorarsine $(C_6H_5)_2\text{-}AsCl$	Smoke	Shoe polish	Causes sick feeling and headache	First-aid treatment	Gas mask	Remove to pure air, keep quiet. Sniff chlorine from bleaching-powder bottle	Summer 10 minutes	Bleaching powder solution
Smokes	HC Mixture $ZN + C_2Cl_6$	Smoke	Sharp-acrid	Harmless	Smoke	None needed	Produces no effect requiring treatment	While burning	None needed
Smokes	Sulphur Trioxide $SO_3 + SO_3HCl$ In chlorsulfonic acid	Smoke	Burning matches	Causes prickling of skin, flow of tears	Smoke	Gas mask	Wash with soda solution	5 to 10 minutes	Alkaline solution
Smokes	Titaniumtetrachloride $TiCl_4$	Smoke	Acrid	Harmless	Smoke	None needed	Produces no effect requiring treatment	10 minutes	None needed
Smokes / Incendiaries	White Phosphorus P	Smoke	Burning matches	Burning pieces adhere to skin and clothing	First-aid treatment	None needed	Pack in cloths wet with copper sulphate (blue vitriol) or water or immerse in water. Pick or squeeze out particles. Treat for burn	10 minutes	Burns out
Incendiaries	Thermit $8Al + 3FeO_4$	Incendiary	None	5,000° heat ignites materials	Incendiary	None needed	Treat for severe burn	5 minutes	Quickly cover with dry earth or sand

From *Army Ordnance*, March-April, 1942.

General Instructions — Protective masks suitable for fire fighting and for mine rescue work are not suitable anti-gas devices. The only masks that are effective against all common war gases are those manufactured according to the Chemical Warfare Service specifications and procurable through the Office of Civilian Defense. General manufacture and public sale of gas masks is prohibited by War Production Board's General Limitation Order L-57, March 3, 1942.

The importance of proper first aid for gas victims cannot be overemphasized. The following are general rules which apply in all cases.

A. Act promptly and quietly; be calm.

B. Put a gas mask on the patient if gas is still present or, if he has a mask on, check to see that his is properly adjusted. If a mask is not available, wet a handkerchief or other cloth and have him breathe through it.

C. Keep the patient at absolute rest; loosen clothing to facilitate breathing.

D. Remove the patient to a gas-free place as soon as possible.

E. Summon medical aid promptly; if possible, send the victim to a hospital.

F. Do not permit the patient to smoke, as this causes coughing and, hence, exertion.

TIME ★ ★ ★ *the Vital Factor!*

TIME has proven the value of our QUENCHING OIL

See Us At The Metal Show C-336

- "163,079 tons of steel quenched in 30,245 gallon of oil."
- "Laboratory reports show physical properties in perfect order."
- "No cracking or checking."
- "Your oil has been highly satisfactory."

The above is a quotation from a letter we received (which we will be glad to show) from one of the larger munition plants.

What more need be said?

INDUSTRIAL LUBRICANTS

The J. W. KELLEY Co.

13209 ATHENS AVE. · CLEVELAND, OHIO

ERIE · BUFFALO · SYRACUSE · DETROIT · INDIANAPOLIS

DIRECT REPEATED STRESSES

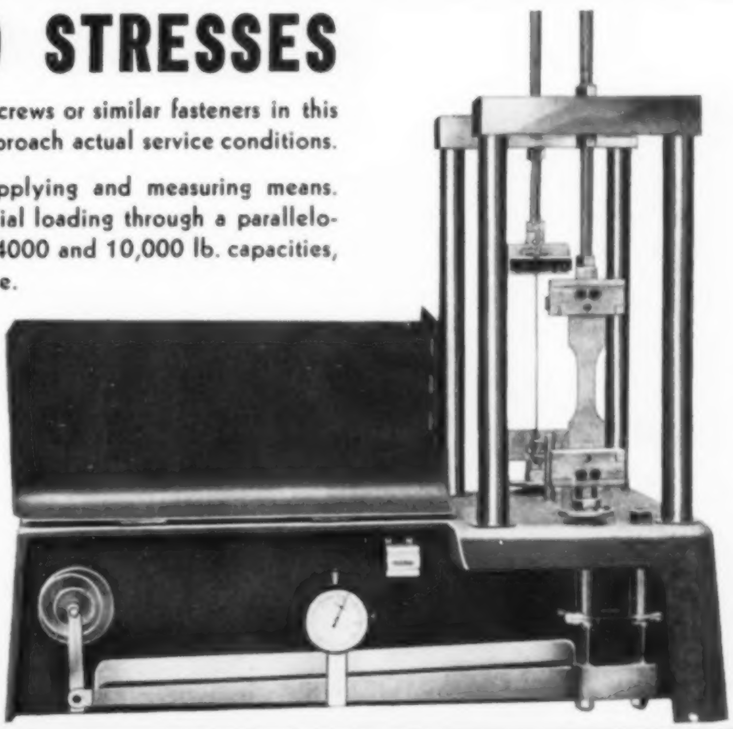
May be applied to riveted joints, spot welds, cap screws or similar fasteners in this machine where laboratory tests may be made to approach actual service conditions.

This machine uses a flexible lever as the load applying and measuring means. Flexure plates act as frictionless bearings assuring axial loading through a parallelogram system. Three sizes of machines have 1000, 4000 and 10,000 lb. capacities, each unit testing two independent specimens at once.

Investigate the unusual features of this machine at our

METAL SHOW
BOOTH C-420

or write for the new catalog describing our complete line.



TESTING SERVICE

More than 10 years of experience in design and testing of repeated stress machines has given us valuable information for the solution of fatigue problems. We have equipment for making routine or special repeated stress tests and should your problem require a special testing machine our design and manufacturing facilities are available at all times.

KROUSE TESTING MACHINE COMPANY

573 EAST ELEVENTH AVENUE · COLUMBUS, OHIO

Conversion Tables for Lengths

Based on value 1 m. = 39.37 in.

From "Ready Reference Tables", by Carl Hering

In. = Mm. = Feet = M. = Yd. = Miles = Km. =	millimeters	inches	meters	feet	meters	yards	kilometers	miles
1	25.400 1	0.039 370	0.304 801	3.280 83	0.914 402	1.093 61	1.609 35	0.621 37
2	50.800 1	0.078 740	0.609 601	6.561 67	1.828 80	2.187 22	3.218 69	1.242 74
3	76.200 2	0.118 110	0.914 402	9.842 50	2.743 21	3.280 83	4.828 04	1.864 11
4	101.600	0.157 480	1.219 20	13.123 3	3.657 61	4.374 44	6.437 39	2.485 48
5	127.000	0.196 850	1.524 00	16.404 2	4.572 01	5.468 06	8.046 74	3.106 85
6	152.400	0.236 220	1.828 80	19.685 0	5.486 41	6.561 67	9.656 08	3.728 22
7	177.800	0.275 590	2.133 60	22.965 8	6.400 81	7.655 28	11.265 4	4.349 59
8	203.200	0.314 960	2.438 40	26.246 7	7.315 21	8.748 89	12.874 8	4.970 96
9	228.600	0.354 330	2.743 21	29.527 5	8.229 62	9.842 50	14.484 1	5.592 33
10	254.001	0.393 700	3.048 01	32.808 3	9.144 02	10.936 1	16.093 5	6.213 70
11	279.401	0.433 070	3.352 81	36.089 2	10.058 4	12.029 7	17.702 8	6.835 07
12	304.801	0.472 440	3.657 61	39.370 0	10.972 8	13.123 3	19.312 2	7.456 44
13	330.201	0.511 810	3.962 41	42.650 8	11.887 2	14.216 9	20.921 5	8.077 81
14	355.601	0.551 180	4.267 21	45.931 7	12.801 6	15.310 6	22.530 9	8.699 18
15	381.001	0.590 550	4.572 01	49.212 5	13.716 0	16.404 2	24.140 2	9.320 55
16	406.401	0.629 920	4.876 81	52.493 3	14.630 4	17.497 8	25.749 6	9.941 92
17	431.801	0.669 290	5.181 61	55.774 2	15.544 8	18.591 4	27.358 9	10.563 3
18	457.201	0.708 660	5.486 41	59.055 0	16.459 2	19.685 0	28.968 2	11.184 7
19	482.601	0.748 030	5.791 21	62.335 8	17.373 6	20.778 6	30.577 6	11.806 0
20	508.001	0.787 400	6.096 01	65.616 7	18.288 0	21.872 2	32.186 9	12.427 4
21	533.401	0.826 770	6.400 81	68.897 5	19.202 4	22.965 8	33.196 3	13.048 8
22	558.801	0.866 140	6.705 61	72.178 3	20.116 8	24.059 4	35.405 6	13.670 1
23	584.201	0.905 510	7.010 41	75.459 2	21.031 2	25.153 1	37.015 0	14.291 5
24	609.601	0.944 880	7.315 21	78.740 0	21.945 6	26.246 7	38.624 3	14.912 9
25	635.001	0.984 250	7.620 02	82.020 8	22.860 0	27.340 3	40.233 7	15.534 2
26	660.401	1.023 62	7.924 82	85.301 7	23.774 4	28.433 9	41.843 0	16.155 6
27	685.801	1.062 99	8.229 62	88.582 5	24.688 9	29.527 5	43.452 4	16.777 0
28	711.201	1.102 36	8.534 42	91.863 3	25.603 3	30.621 1	45.061 7	17.398 4
29	736.601	1.141 73	8.839 22	95.144 2	26.517 7	31.714 7	46.671 1	18.019 7
30	762.002	1.181 10	9.144 02	98.425 0	27.432 1	32.808 3	48.280 4	18.641 1
31	787.402	1.220 47	9.448 82	101.706	28.346 5	33.901 9	49.889 8	19.262 5
32	812.802	1.259 84	9.753 62	104.987	29.260 9	34.995 6	51.499 1	19.883 8
33	838.202	1.299 21	10.058 4	108.268	30.175 3	36.089 2	53.108 5	20.505 2
34	863.602	1.338 58	10.363 2	111.548	31.089 7	37.182 8	54.717 8	21.126 6
35	889.002	1.377 95	10.668 0	114.829	32.004 1	38.276 4	56.327 2	21.747 9
36	914.402	1.417 32	10.972 8	118.110	32.918 5	39.370 0	57.936 5	22.369 3
37	939.802	1.456 69	11.277 6	121.391	33.832 9	40.463 6	59.545 8	22.990 7
38	965.202	1.496 06	11.582 4	124.672	34.747 3	41.557 2	61.155 2	23.612 1
39	990.602	1.535 43	11.887 2	127.953	35.661 7	42.650 8	62.764 5	24.233 4
40	1 016.00	1.574 80	12.192 0	131.233	36.576 1	43.744 4	64.373 9	24.854 8
41	1 041.40	1.614 17	12.496 8	134.514	37.490 5	44.838 1	65.983 2	25.476 2
42	1 066.80	1.653 54	12.801 6	137.795	38.404 9	45.931 7	67.592 6	26.097 5
43	1 092.20	1.692 91	13.106 4	141.076	39.319 3	47.025 3	69.201 9	26.718 9
44	1 117.60	1.732 28	13.411 2	144.357	40.233 7	48.118 9	70.811 3	27.340 3
45	1 143.00	1.771 65	13.716 0	147.638	41.148 1	49.212 5	72.420 6	27.961 6
46	1 168.40	1.811 02	14.020 8	150.918	42.062 5	50.306 1	74.030 0	28.583 0
47	1 193.80	1.850 39	14.325 6	154.199	42.976 9	51.399 7	75.639 3	29.204 4
48	1 219.20	1.889 76	14.630 4	157.480	43.891 3	52.493 3	77.248 7	29.825 8
49	1 244.60	1.929 13	14.935 2	160.761	44.805 7	53.586 9	78.858 0	30.447 1
50	1 270.00	1.968 50	15.240 0	164.042	45.720 1	54.680 6	80.467 4	31.068 5
51	1 295.40	2.007 87	15.544 8	167.323	46.634 5	55.774 2	82.076 7	31.689 9
52	1 320.80	2.047 24	15.849 6	170.603	47.548 9	56.867 8	83.686 1	32.311 2
53	1 346.20	2.086 61	16.154 4	173.884	48.463 3	57.961 4	85.295 4	32.932 6
54	1 371.60	2.125 98	16.459 2	177.165	49.377 7	59.055 0	86.904 7	33.554 0
55	1 397.00	2.165 35	16.764 0	180.446	50.292 1	60.148 6	88.514 1	34.175 3
56	1 422.40	2.204 72	17.068 8	183.727	51.206 5	61.242 2	90.123 4	34.796 7
57	1 447.80	2.244 09	17.373 6	187.008	52.120 9	62.335 8	91.732 8	35.418 1
58	1 473.20	2.283 46	17.678 4	190.288	53.035 3	63.429 4	93.342 1	36.039 5
59	1 498.60	2.322 83	17.983 2	193.569	53.949 7	64.523 1	94.951 5	36.660 8
60	1 524.00	2.362 20	18.288 0	196.850	54.864 1	65.616 7	96.560 8	37.282 2
61	1 549.40	2.401 57	18.592 8	200.131	55.778 5	66.710 3	98.170 2	37.903 6
62	1 574.80	2.440 94	18.897 6	203.412	56.692 9	67.803 9	99.779 5	38.524 9
63	1 600.20	2.480 31	19.202 4	206.693	57.607 3	68.897 5	101.389	39.146 3
64	1 625.60	2.519 68	19.507 2	209.973	58.521 7	69.991 1	102.998	39.767 7
65	1 651.00	2.559 05	19.812 0	213.254	59.436 1	71.084 7	104.608	40.389 0
66	1 676.40	2.598 42	20.116 8	216.535	60.350 5	72.178 3	106.217	41.010 4
67	1 701.80	2.637 79	20.421 6	219.816	61.264 9	73.271 9	107.826	41.631 8
68	1 727.20	2.677 16	20.726 4	223.097	62.179 3	74.365 6	109.436	42.253 2
69	1 752.60	2.716 53	21.031 2	226.378	63.093 7	75.459 2	111.045	42.874 5
70	1 778.00	2.755 90	21.336 0	229.658	64.008 1	76.552 8	112.654	43.495 9
71	1 803.40	2.795 27	21.640 8	232.939	64.922 5	77.646 4	114.264	44.117 3
72	1 828.80	2.834 64	21.945 6	236.220	65.836 9	78.740 0	115.873	44.738 6
73	1 854.20	2.874 01	22.250 4	239.501	66.751 3	79.833 6	117.482	45.360 0
74	1 879.60	2.913 38	22.555 2	242.782	67.665 7	80.927 2	119.092	45.981 4
75	1 905.00	2.952 75	22.860 0	246.063	68.580 1	82.020 8	120.701	46.602 7
76	1 930.40	2.992 12	23.164 8	249.343	69.494 5	83.114 4	122.310	47.224 1
77	1 955.80	3.031 49	23.469 6	252.624	70.408 9	84.208 1	123.920	47.845 5
78	1 981.20	3.070 86	23.774 4	255.905	71.323 3	85.301 7	125.529	48.466 9
79	2 006.60	3.110 23	24.079 2	259.186	72.237 7	86.395 3	127.138	49.088 2
80	2 032.00	3.149 60	24.384 0	262.467	73.152 1	87.488 9	128.748	49.709 6
81	2 057.40	3.188 97	24.688 8	265.748	74.066 5	88.582 5	130.357	50.331 0
82	2 082.80	3.228 34	24.993 6	269.028	74.981 0	89.676 1	131.966	50.952 3
83	2 108.20	3.267 71	25.298 4	272.309	75.895 4	90.769 7	133.576	51.573 7
84	2 133.60	3.307 08	25.603 3	275.590	76.809 8	91.863 3	135.185	52.195 1
85	2 159.00	3.346 45	25.908 1	278.871	77.724 2	92.956 9	136.795	52.816 4
86	2 184.40	3.385 82	26.212 9	282.152	78.638 6	94.050 6	138.404	53.437 8
87	2 209.80	3.425 19	26.517 7	285.433	79.553 0	95.144 2	140.013	54.059 2
88	2 235.20	3.464 56	26.822 5	288.713	80.467 4	96.237 8	141.623	54.680 6
89	2 260.60	3.503 93	27.127 3	291.994	81.381 8	97.331 4	143.232	55.301 9
90	2 286.00	3.543 30	27.432 1	295.275	82.296 2	98.425 0	144.841	55.923 3
91	2 311.40	3.582 67	27.736 9	298.556	83.210 6	99.518 6	146.451	56.544 7
92	2 336.80	3.622 04	28.041 7	301.837	84.125 0	100.612	148.060	57.166 0
93	2 362.20	3.661 41	28.346 5	305.118	85.039 4	101.706	149.669	57.787 4
94	2 387.60	3.700 78	28.651 3	308.398	85.953 8	102.799	151.279	58.408 8
95	2 413.00	3.740 15	28.956 1	311.679	86.868 2	103.893	152.888	59.030 1
96	2 438.40	3.779 52	29.260 9	314.960	87.782 6	104.987	154.497	59.651 5
97	2 463.80	3.818 89	29.565 7	318.241	88.697 0	106.080	156.107	60.272 9
98	2 489.20	3.858 26	29.870 5	321.522	89.611 4	107.174	157.716	60.894 3
99	2 514.60	3.897 63	30.175 3	324.803	90.525 8	108.268	159.325	61.515 6
100	2 540.01	3.937 00	30.480 1	328.083	91.440 2	109.361	160.935	62.137 0

Temperature Conversions

Albert Sauveur type of table. Look up reading in middle column; if in degrees Centigrade, read Fahrenheit equivalent in right hand column; if in degrees Fahrenheit, read Centigrade equivalent in left hand column. Values as printed in "Bethlehem Alloy Steels".

−459.4 to 0			0 to 100						100 to 1000						1000 to 2000						2000 to 3000					
C		F	C		F	C		F	C		F	C		F	C		F	C		F	C		F	C		F
−273	−459.4		−17.8	0	32	10.0	50	122.0	38	100	212	260	500	932	538	1000	1832	816	1500	2732	1093	2000	3632	1371	2500	4532
−268	−450		−17.2	1	33.8	10.6	51	123.8	43	110	230	266	510	950	543	1010	1850	821	1510	2750	1099	2010	3650	1377	2510	4550
−262	−440		−16.7	2	35.6	11.1	52	125.6	49	120	248	271	520	968	549	1020	1868	827	1520	2768	1104	2020	3668	1382	2520	4568
−257	−430		−16.1	3	37.4	11.7	53	127.4	54	130	266	277	530	986	554	1030	1886	832	1530	2786	1110	2030	3686	1388	2530	4586
−251	−420		−15.6	4	39.2	12.2	54	129.2	60	140	284	282	540	1004	560	1040	1904	838	1540	2804	1116	2040	3704	1393	2540	4604
−246	−410		−15.0	5	41.0	12.8	55	131.0	66	150	302	288	550	1022	566	1050	1922	843	1550	2822	1121	2050	3722	1399	2550	4622
−240	−400		−14.4	6	42.8	13.3	56	132.8	71	160	320	293	560	1040	571	1060	1940	849	1560	2840	1127	2060	3740	1404	2560	4640
−234	−390		−13.9	7	44.6	13.9	57	134.6	77	170	338	299	570	1058	577	1070	1958	854	1570	2858	1132	2070	3758	1410	2570	4658
−229	−380		−13.3	8	46.4	14.4	58	136.4	82	180	356	304	580	1076	582	1080	1976	860	1580	2876	1138	2080	3776	1416	2580	4676
−223	−370		−12.8	9	48.2	15.0	59	138.2	88	190	374	310	590	1094	588	1090	1994	866	1590	2894	1143	2090	3794	1421	2590	4694
−218	−360		−12.2	10	50.0	15.6	60	140.0	93	200	392	316	600	1112	593	1100	2012	871	1600	2912	1149	2100	3812	1427	2600	4712
−212	−350		−11.7	11	51.8	16.1	61	141.8	99	210	410	321	610	1130	599	1110	2030	877	1610	2930	1154	2110	3830	1432	2610	4730
−207	−340		−11.1	12	53.6	16.7	62	143.6	100	212	413.6	327	620	1148	604	1120	2048	882	1620	2948	1160	2120	3848	1438	2620	4748
−201	−330		−10.6	13	55.4	17.2	63	145.4	104	220	428	332	630	1166	610	1130	2066	888	1630	2966	1166	2130	3866	1443	2630	4766
−196	−320		−10.0	14	57.2	17.8	64	147.2	110	230	446	338	640	1184	616	1140	2084	893	1640	2984	1171	2140	3884	1449	2640	4784
−190	−310		−9.4	15	59.0	18.3	65	149.0	116	240	464	343	650	1202	621	1150	2102	899	1650	3002	1177	2150	3902	1454	2650	4802
−184	−300		−8.9	16	60.8	18.9	66	150.8	121	250	482	349	660	1220	627	1160	2120	904	1660	3020	1182	2160	3920	1460	2660	4820
−179	−290		−8.3	17	62.6	19.4	67	152.6	127	260	500	354	670	1238	632	1170	2138	910	1670	3038	1188	2170	3938	1466	2670	4838
−173	−280		−7.8	18	64.4	20.0	68	154.4	132	270	518	360	680	1256	638	1180	2156	916	1680	3056	1193	2180	3956	1471	2680	4856
−169	−273	−459.4	−7.2	19	66.2	20.6	69	156.2	138	280	536	366	690	1274	643	1190	2174	921	1690	3074	1199	2190	3974	1477	2690	4874
−168	−270	−454	−6.7	20	68.0	21.1	70	158.0	143	290	554	371	700	1292	649	1200	2192	927	1700	3092	1204	2200	3992	1482	2700	4892
−162	−260	−436	−6.1	21	69.8	21.7	71	159.8	149	300	572	377	710	1310	654	1210	2210	932	1710	3110	1210	2210	4010	1488	2710	4910
−157	−250	−418	−5.6	22	71.6	22.2	72	161.6	154	310	590	382	720	1328	660	1220	2228	938	1720	3128	1216	2220	4028	1493	2720	4928
−151	−240	−400	−5.0	23	73.4	22.8	73	163.4	160	320	608	388	730	1346	666	1230	2246	943	1730	3146	1221	2230	4046	1499	2730	4946
−146	−230	−382	−4.4	24	75.2	23.3	74	165.2	166	330	626	393	740	1364	671	1240	2264	949	1740	3164	1227	2240	4064	1504	2740	4964
−140	−220	−364	−3.9	25	77.0	23.9	75	167.0	171	340	644	399	750	1382	677	1250	2282	954	1750	3182	1232	2250	4082	1510	2750	4982
−134	−210	−346	−3.3	26	78.8	24.4	76	168.8	177	350	662	404	760	1400	682	1260	2300	960	1760	3200	1238	2260	4100	1516	2760	5000
−129	−200	−328	−2.8	27	80.6	25.0	77	170.6	182	360	680	410	770	1418	688	1270	2318	966	1770	3218	1243	2270	4118	1521	2770	5018
−123	−190	−310	−2.2	28	82.4	25.6	78	172.4	188	370	698	416	780	1436	693	1280	2336	971	1780	3236	1249	2280	4136	1527	2780	5036
−118	−180	−292	−1.7	29	84.2	26.1	79	174.2	193	380	716	421	790	1454	699	1290	2354	977	1790	3254	1254	2290	4154	1532	2790	5054
−112	−170	−274	−1.1	30	86.0	26.7	80	176.0	199	390	734	427	800	1472	704	1300	2372	982	1800	3272	1260	2300	4172	1538	2800	5072
−107	−160	−256	−0.6	31	87.8	27.2	81	177.8	204	400	752	432	810	1490	710	1310	2390	988	1810	3290	1266	2310	4190	1543	2810	5090
−101	−150	−238	0.0	32	89.6	27.8	82	179.6	210	410	770	438	820	1508	716	1320	2408	993	1820	3308	1271	2320	4208	1549	2820	5108
−96	−140	−220	0.6	33	91.4	28.3	83	181.4	216	420	788	443	830	1526	721	1330	2426	999	1830	3326	1277	2330	4226	1554	2830	5126
−90	−130	−202	1.1	34	93.2	28.9	84	183.2	221	430	806	449	840	1544	727	1340	2444	1004	1840	3344	1282	2340	4244	1560	2840	5144
−84	−120	−184	1.7	35	95.0	29.4	85	185.0	227	440	824	454	850	1562	732	1350	2462	1010	1850	3362	1288	2350	4262	1566	2850	5162
−79	−110	−166	2.2	36	96.8	30.0	86	186.8	232	450	842	460	860	1580	738	1360	2480	1016	1860	3380	1293	2360	4280	1571	2860	5180
−73	−100	−148	2.8	37	98.6	30.6	87	188.6	238	460	860	466	870	1598	743	1370	2498	1021	1870	3398	1299	2370	4298	1577	2870	5198
−68	−90	−130	3.3	38	100.4	31.1	88	190.4	243	470	878	471	880	1616	749	1380	2516	1027	1880	3416	1304	2380	4316	1582	2880	5216
−62	−80	−112	3.9	39	102.2	31.7	89	192.2	249	480	896	477	890	1634	754	1390	2534	1032	1890	3434	1310	2390	4334	1588	2890	5234
−57	−70	−94	4.4	40	104.0	32.2	90	194.0	254	490	914	482	900	1652	760	1400	2552	1038	1900	3452	1316	2400	4352	1593	2900	5252
−51	−60	−76	5.0	41	105.8	32.8	91	195.8				488	910	1670	766	1410	2570	1043	1910	3470	1321	2410	4370	1599	2910	5270
−46	−50	−58	5.6	42	107.6	33.3	92	197.6				493	920	1688	771	1420	2588	1049	1920	3488	1327	2420	4388	1604	2920	5288
−40	−40	−40	6.1	43	109.4	33.9	93	199.4				499	930	1706	777	1430	2606	1054	1930	3506	1332	2430	4406	1610	2930	5306
−34	−30	−22	6.7	44	111.2	34.4	94	201.2				504	940	1724	782	1440	2624	1060	1940	3524	1338	2440	4424	1616	2940	5324
−29	−20	−4	7.2	45	113.0	35.0	95	203.0				510	950	1742	788	1450	2642	1066	1950	3542	1343	2450	4442	1621	2950	5342
−23	−10	14	7.8	46	114.8	35.6	96	204.8				516	960	1760	793	1460	2660	1071	1960	3560	1349	2460	4460	1627	2960	5360
−17.8	0	32	8.3	47	116.6	36.1	97	206.6				521	970	1778	799	1470	2678	1077	1970	3578	1354	2470	4478	1632	2970	5378
			8.9	48	118.4	36.7	98	208.4				527	980	1796	804	1480	2696	1082	1980	3596	1360	2480	4496	1638	2980	5396
			9.4	49	120.2	37.2	99	210.2				532	990	1814	810	1490	2714	1088	1990	3614	1366	2490	4514	1643	2990	5414
						37.8	100	212.0				538	1000	1832				1093	2000	3632				1649	3000	5432

A.I.S.I. Standard Steel Compositions

Revised Aug. 17, 1942

CODE:

A is basic openhearth alloy steel.
B is acid bessemer carbon steel.
C is basic openhearth carbon steel.
D is acid openhearth carbon steel.
E is electric furnace steel.
NE is National Emergency standard steel; designation promulgated by W.P.B.
Q is forging quality, or special requirement quality.
R is re-rolling quality billets.

Basic Openhearth and Acid Bessemer Carbon Steels

AISI Number	Semi-finish	Bars	Wire Rods	C	Mn	P (b)	S (b)	'42 SAE Number
C 1005	—	—	√	0.06 max.	0.35 max.	0.04	0.05	....
C 1006*	Q, R	√	√	0.08 max.	0.25–0.40	0.04	0.05	....
C 1008*	Q, R	√	√	0.10 max.	0.30–0.50	0.04	0.05	1008
CB 1008	—	√	√	0.10 max.	....	....	....	....
C 1009	Q	—	—	0.07–0.12	0.25–0.40	0.04	0.05	....
C 1010*	Q, R	√	√	0.08–0.13	0.30–0.50	0.04	0.05	1010
C 1012	Q	√	√	0.10–0.15	0.30–0.50	0.04	0.05	....
CB 1012	—	√	—	0.15 max.	....	....	....	....
C 1013	—	—	√	0.11–0.16	0.60–0.90	0.04	0.05	....
C 1014	Q	√	√	0.13–0.18	0.40–0.60	0.04	0.05	....
C 1015*	Q, R	√	√	0.13–0.18	0.30–0.50	0.04	0.05	1015
C 1016	Q	√	√	0.13–0.18	0.60–0.90	0.04	0.05	1016
CB 1017	—	√	—	0.10–0.25	....	....	....	....
C 1017	Q	√	√	0.15–0.20	0.30–0.50	0.04	0.05	....
C 1018	Q	√	√	0.15–0.20	0.60–0.80	0.04	0.05	....
C 1019	Q	√	√	0.15–0.20	0.70–1.00	0.04	0.05	....
C 1020*	Q, R	√	√	0.18–0.23	0.30–0.50	0.04	0.05	1020
C 1021	Q	√	√	0.18–0.23	0.40–0.60	0.04	0.05	....
C 1022	Q	√	√	0.18–0.23	0.70–1.00	0.04	0.05	1022
C 1023	Q	√	√	0.20–0.25	0.30–0.50	0.04	0.05	....
C 1024	—	√	—	0.20–0.26	1.35–1.65	0.04	0.05	1024
C 1025*	Q, R	√	√	0.22–0.28	0.30–0.50	0.04	0.05	1025
C 1026	Q	√	√	0.22–0.28	0.40–0.60	0.04	0.05	....
C 1027	—	—	√	0.24–0.30	0.40–0.60	0.04	0.05	....
C 1029	Q	√	—	0.25–0.31	0.60–0.90	0.04	0.05	....
C 1030	Q	√	√	0.28–0.34	0.60–0.90	0.04	0.05	1030
C 1031	Q	—	—	0.28–0.34	0.40–0.60	0.04	0.05	....
CB 1032	R	√	—	0.25–0.40	....	....	....	....
C 1033	Q	√	—	0.30–0.36	0.60–0.90	0.04	0.05	....
C 1034	—	—	√	0.32–0.38	0.50–0.70	0.04	0.05	....
C 1035	Q	√	—	0.32–0.38	0.60–0.90	0.04	0.05	1035
C 1036	—	√	—	0.32–0.39	1.20–1.50	0.04	0.05	1036
C 1038	Q	—	√	0.35–0.42	0.60–0.90	0.04	0.05	....
C 1040	Q	√	√	0.37–0.44	0.60–0.90	0.04	0.05	1040
C 1041	—	—	√	0.36–0.44	1.35–1.65	0.04	0.05	....
C 1042	Q	√	—	0.40–0.47	0.60–0.90	0.04	0.05	....
C 1043	Q	√	—	0.40–0.47	0.70–1.00	0.04	0.05	....
C 1044	—	—	√	0.43–0.50	0.50–0.70	0.04	0.05	....
C 1045	Q	√	—	0.43–0.50	0.60–0.90	0.04	0.05	1045
C 1046	Q	—	—	0.43–0.50	0.70–1.00	0.04	0.05	....
C 1050	Q	√	—	0.45–0.55	0.60–0.90	0.04	0.05	1050
C 1051	—	—	√	0.45–0.56	0.85–1.15	0.04	0.05	....
C 1052	—	√	—	0.47–0.55	1.20–1.50	0.04	0.05	1052
C 1054	—	—	√	0.50–0.60	0.50–0.70	0.04	0.05	....
C 1055	Q	√	—	0.50–0.60	0.60–0.90	0.04	0.05	1055
C 1057	—	—	√	0.50–0.61	0.85–1.15	0.04	0.05	....
C 1059	—	—	√	0.55–0.65	0.50–0.70	0.04	0.05	....
C 1060	—	√	√	0.55–0.65	0.60–0.90	0.04	0.05	1060
C 1061	—	√	—	0.54–0.65	0.75–1.05	0.04	0.05	....
C 1062	—	—	√	0.54–0.65	0.85–1.15	0.04	0.05	....
C 1064	—	√	√	0.60–0.70	0.50–0.70	0.04	0.05	....
C 1066	—	√	√	0.60–0.71	0.80–1.10	0.04	0.05	1066
C 1068	—	√	—	0.65–0.75	0.50 max.	0.04	0.05	....
C 1069	—	—	√	0.65–0.75	0.50–0.70	0.04	0.05	....
C 1070	—	√	—	0.65–0.75	0.70–1.00	0.04	0.05	1070
C 1074	—	√	√	0.70–0.80	0.50–0.70	0.04	0.05	....
C 1075	—	—	√	0.70–0.80	0.60–0.80	0.04	0.05	....
C 1076	Q	—	—	0.70–0.80	0.60–0.90	0.04	0.05	....
C 1078	—	√	√	0.72–0.85	0.30–0.50	0.04	0.05	....
C 1080	—	√	—	0.75–0.88	0.60–0.90	0.04	0.05	1080
C 1084	Q	—	—	0.80–0.93	0.60–0.90	0.04	0.05	....
C 1085	Q	√	—	0.80–0.95	0.60–0.90	0.04	0.05	1085
C 1086	—	√	√	0.82–0.95	0.30–0.50	0.04	0.05	....
C 1090	Q	—	—	0.85–1.00	0.60–0.90	0.04	0.05	....
C 1095	—	√	√	0.90–1.05	0.30–0.50	0.04	0.05	1095
B 1006	—	—	√	0.08 max.	0.45 max.	0.11	0.06	....
B 1008	R	√	—	0.10 max.	0.30–0.50	0.11	0.06	....
B 1011	—	√	√	0.13 max.	0.25–0.50	0.11	0.06	....

Note 1: When silicon is specified in standard basic openhearth steels, silicon may be ordered only as 0.10 per cent maximum; 0.10 to 0.20 per cent; or 0.15 to 0.30 per cent. In the case of many grades of basic openhearth steel, special practice is necessary in order to comply with a specification including silicon.

Note 2: Acid bessemer steel is not furnished with specified silicon content.

Sulphurized or Phosphorized Carbon Steels

AISI Number	Semi-finish	Bars	Wire Rods	C	Mn	P (b)	S (b)	'42 SAE Number
B 1106	—	—	√	0.09 max.	0.50 max.	0.11 max.	0.04–0.09	....
C 1108	—	—	√	0.08–0.13	0.50–0.70	0.045 max.	0.07–0.12	....
C 1109	Q	√	√	0.08–0.13	0.60–0.90	0.045 max.	0.08–0.13	....
B 1110	—	√	√	0.13 max.	0.60 max.	0.11 max.	0.045–0.075	....
C 1110	—	√	√	0.08–0.13	0.60–0.90	0.045 max.	0.10–0.15	....
B 1111	—	√	√	0.08–0.13	0.60–0.90	0.09–0.13	0.10–0.15	1111
C 1111	—	—	√	0.08–0.13	0.60–0.90	0.045 max.	0.16–0.23	....
B 1112	—	√	√	0.08–0.13	0.60–0.90	0.09–0.13	0.16–0.23	1112
C 1112	—	√	—	0.10–0.16	1.00–1.30	0.045 max.	0.08–0.13	....
B 1113	—	√	√	0.08–0.13	0.60–0.90	0.09–0.13	0.24–0.33	1113
C 1113	Q	√	—	0.10–0.16	1.00–1.30	0.045 max.	0.24–0.33	....
C 1114	R	—	—	0.12–0.18	0.45–0.65	0.045 max.	0.075–0.15	....
C 1115	Q	√	√	0.13–0.18	0.70–1.00	0.045 max.	0.10–0.15	1115
C 1116	Q	√	√	0.13–0.18	0.70–1.00	0.045 max.	0.10–0.15	....
C 1117	—	√	√	0.14–0.20	1.00–1.30	0.045 max.	0.08–0.13	1117
C 1118	Q	√	√	0.14–0.20	1.30–1.60	0.045 max.	0.08–0.13	1118
C 1119	—	—	√	0.14–0.20	1.35–1.65	0.045 max.	0.16–0.23	....
C 1120*	Q, R	√	√	0.18–0.23	0.60–0.90	0.045 max.	0.08–0.13	....
C 1121	Q	√	√	0.18–0.23	0.70–1.00	0.045 max.	0.08–0.13	....
C 1122	Q	√	√	0.17–0.23	1.35–1.65	0.045 max.	0.08–0.13	....
C 1132	Q	√	√	0.27–0.34	1.35–1.65	0.045 max.	0.08–0.13	1132
C 1137	Q	√	√	0.32–0.39	1.35–1.65	0.045 max.	0.08–0.13	1137
C 1140‡	Q	√	—	0.37–0.44	0.60–0.90	0.045 max.	0.04–0.07	....
C 1141	—	√	—	0.37–0.45	1.35–1.65	0.045 max.	0.08–0.13	1141
C 1144	—	√	—	0.40–0.48	1.35–1.65	0.045 max.	0.24–0.33	....
C 1145‡	Q	√	—	0.42–0.49	0.70–1.00	0.045 max.	0.04–0.07	1145
C 1205	Q	—	√	0.08 max.	0.25–0.40	0.04–0.07	0.05 max.	....
C 1206	R	—	√	0.08 max.	0.25–0.40	0.04–0.07	0.05 max.	....
C 1209	R	—	√	0.08–0.13	0.30–0.50	0.05–0.10	0.05 max.	....
C 1210	Q	—	√	0.08–0.13	0.30–0.50	0.06–0.10	0.05 max.	....
C 1211	—	—	√	0.08–0.13	0.60–0.90	0.09–0.13	0.10–0.15	....
C 1217	—	√	—	0.14–0.19	0.70–1.00	0.09–0.13	0.20–0.29	....

*Compositions given are for forging quality; re-rolling quality differs slightly in analysis.

(b)—Phosphorus and sulphur are maximum for basic openhearth and acid bessemer steels; sulphurized or phosphorized steels are not subject to check analysis for S or P.

Notes: Acid bessemer steels (B series) are not furnished with specified silicon content.

‡Standard steels C 1140 and C 1145 may be ordered with silicon content either as 0.10% max., 0.10 to 0.20%, or 0.15 to 0.30%.

Openhearth Alloy and Electric Furnace Carbon and Alloy Steels

(Blooms, Billets, Slabs, Bars and Hot Rolled Strip)

AISI Number	C	Mn	P Max.*	S Max.*	Si*	Ni	Cr	Mo	'42 SAE Number
A 1320	0.18–0.23	1.60–1.90	0.040	0.040	0.20–0.35	....	....	....	1320
NE 1330	0.28–0.33	1.60–1.90	0.040	0.040	0.20–0.35	....	....	....	1330
NE 1335	0.33–0.38	1.60–1.90	0.040	0.040	0.20–0.35	....	....	....	1335
NE 1340	0.38–0.43	1.60–1.90	0.040	0.040	0.20–0.35	....	....	....	1340
NE 1345	0.43–0.48	1.60–1.90	0.040	0.040	0.20–0.35	....	....	....	....
NE 1350	0.48–0.53	1.60–1.90	0.040	0.040	0.20–0.35	....	....	....	....
A 2317	0.15–0.20	0.40–0.60	0.040	0.040	0.20–0.35	3.25–3.75	....	....	2317
A 2330	0.28–0.33	0.60–0.80	0.040	0.040	0.20–0.35	3.25–3.75	....	....	2330
A 2335	0.33–0.38	0.60–0.80	0.040	0.040	0.20–0.35	3.25–3.75	....	....	....
A 2340	0.38–0.43	0.70–0.90	0.040	0.040	0.20–0.35	3.25–3.75	....	....	2340
A 2345	0.43–0.48	0.70–0.90	0.040	0.040	0.20–0.35	3.25–3.75	....	....	2345
E 2512	0.09–0.14	0.45–0.60	0.025	0.025	0.20–0.35	4.75–5.25	....	....	....
A 2515	0.12–0.17	0.40–0.60	0.040	0.040	0.20–0.35	4.75–5.25	....	....	2515
E 2517	0.15–0.20	0.45–0.60	0.025	0.025	0.20–0.35	4.75–5.25	....	....	....
A 3045	0.43–0.48	0.75–0.95	0.040	0.040	0.20–0.35	0.60–0.80	0.60–0.80	....	....
A 3115	0.13–0.18	0.40–0.60	0.040	0.040	0.20–0.35	1.10–1.40	0.55–0.75	....	3115
A 3120	0.17–0.22	0.60–0.80	0.040	0.040	0.20–0.35	1.10–1.40	0.55–0.75	....	3120
A 3130	0.28–0.33	0.60–0.80	0.040	0.040	0.20–0.35	1.10–1.40	0.55–0.75	....	3130
A 3135	0.33–0.38	0.60–0.80	0.040	0.040	0.20–0.35	1.10–1.40	0.55–0.75	....	3135
A 3140	0.38–0.43	0.70–0.90	0.040	0.040	0.20–0.35	1.10–1.40	0.55–0.75	....	3140
A 3141	0.38–0.43	0.70–0.90	0.040	0.040	0.20–0.35	1.10–1.40	0.70–0.90	....	3141
A 3145	0.43–0.48	0.70–0.90	0.040	0.040	0.20–0.35	1.10–1.40	0.70–0.90	....	3145
A 3150	0.48–0.53	0.70–0.90	0.040	0.040	0.20–0.35	1.10–1.40	0.70–0.90	....	3150
A 3240	0.38–0.45	0.40–0.60	0.040	0.040	0.20–0.35	1.65–2.00	0.90–1.20	....	3240
E 3310	0.08–0.13	0.45–0.60	0.025	0.025	0.20–0.35	3.25–3.75	1.40–1.75	....	3310
E 3316	0.14–0.19	0.45–0.60	0.025	0.025	0.20–0.35	3.25–3.75	1.40–1.75	....	....
A 4023	0.20–0.25	0.70–0.90	0.040	0.040	0.20–0.35	....	....	0.20–0.30	4023
A 4024	0.20–0.25	0.70–0.90	0.040	(a)	0.20–0.35	....	....	0.20–0.30	....
A 4027	0.25–0.30	0.70–0.90	0.040	0.040	0.20–0.35	....	....	0.20–0.30	4027
A 4028	0.25–0.30	0.70–0.90	0.040	(a)	0.20–0.35	....	....	0.20–0.30	....
A 4032	0.30–0.35	0.70–0.90	0.040	0.040	0.20–0.35	....	....	0.20–0.30	4032
A 4037	0.35–0.40	0.75–1.00	0.040	0.040	0.20–0.35	....	....	0.20–0.30	4037
A 4042	0.40–0.45	0.75–1.00	0.040	0.040	0.20–0.35	....	....	0.20–0.30	4042
A 4047	0.45–0.50	0.75–1.00	0.040	0.040	0.20–0.35	....	....	0.20–0.30	4047
A 4063	0.60–0.67	0.75–1.00	0.040	0.040	0.20–0.35	....	....	0.20–0.30	4063
A 4068	0.64–0.72	0.75–1.00	0.040	0.040	0.20–0.35	....	....	0.20–0.30	4068
NE 8020	0.18–0.23	1.00–1.30	0.040	0.040	0.20–0.35	....	....	0.10–0.20	....
NE 8022	0.20–0.25	1.00–1.30	0.040	0.040	0.20–0.35	....	....	0.10–0.20	....
NE 8339	0.35–0.42	1.30–1.60	0.040	0.040	0.20–0.35	....	....	0.20–0.30	....
NE 8442	0.40–0.45	1.30–1.60	0.040	0.040	0.20–0.35	....	....	0.30–0.40	....
A 4119	0.17–0.22	0.70–0.90	0.040	0.040	0.20–0.35	....	0.40–0.60	0.20–0.30	4119
A 4120	0.17–0.22	0.70–0.90	0.040	0.040	0.20–0.35	....	0.60–0.80	0.20–0.30	....
A 4125	0.23–0.28	0.70–0.90	0.040	0.040	0.20–0.35	....	0.40–0.60	0.20–0.30	4125
A 4130	0.28–0.33	0.40–0.60	0.040	0.040	0.20–0.35	....	0.80–1.10	0.15–0.25	4130
E 4132	0.30–0.35	0.40–0.60	0.040	0.040	0.20–0.35	....	0.80–1.10	0.18–0.25	....
A 4134	0.32–0.37	0.40–0.60	0.040	0.040	0.20–0.35	....	0.80–1.10	0.15–0.25	....
E 4135	0.33–0.38	0.70–0.90	0.025	0.025	0.20–0.35	....	0.80–1.10	0.18–0.25	....
A 4137	0.35–0.40	0.70–0.90	0.040	0.040	0.20–0.35	....	0.80–1.10	0.15–0.25	4137
E 4137	0.35–0.40	0.70–0.90	0.025	0.025	0.20–0.35	....	0.80–1.10	0.18–0.25	....
A 4140	0.38–0.43	0.75–1.00	0.040	0.040	0.20–0.35	....	0.80–1.10	0.15–0.25	4140
A 4142	0.40–0.45	0.75–1.00	0.040	0.040	0.20–0.35	....	0.80–1.10	0.15–0.25	....
A 4143	0.40–0.45	0.75–1.00	0.040	0.040	0.20–0.35	....	0.80–1.10	0.30–0.40	....
A 4145	0.43–0.48	0.75–1.00	0.040	0.040	0.20–0.35	....	0.80–1.10	0.15–0.25	4145
A 4150	0.46–0.53	0.75–1.00	0.040	0.040	0.20–0.35	....	0.80–1.10	0.15–0.25	4150
E 4150	0.48–0.53	0.70–0.90	0.025	0.025	0.20–0.35	....	0.80–1.10	0.20–0.27	....
NE 8613	0.12–0.17	0.70–0.90	0.040	0.040	0.20–0.35	0.40–0.60	0.40–0.60	0.15–0.25	....
NE 8615	0.13–0.18	0.70–0.90	0.040	0.040	0.20–0.35	0.40–0.60	0.40–0.60	0.15–0.25	....
NE 8617	0.15–0.20	0.70–0.90	0.040	0.040	0.20–0.35	0.40–0.60	0.40–0.60	0.15–0.25	....
NE 8620	0.18–0.23	0.70–0.90	0.040	0.040	0.20–0.35	0.40–0.60	0.40–0.60	0.15–0.25	....
NE 8630	0.28–0.33	0.70–0.90	0.040	0.040	0.20–0.35	0.40–0.60	0.40–0.60	0.15–0.25	....
NE 8715	0.13–0.18	0.70–0.90	0.040	0.040	0.20–0.35	0.40–0.60	0.40–0.60	0.20–0.30	....
NE 8720	0.18–0.23	0.70–0.90	0.040	0.040	0.20–0.35	0.40–0.60	0.40–0.60	0.20–0.30	....
NE 8722	0.20–0.25	0.70–0.90	0.040	0.040	0.20–0.35	0.40–0.60	0.40–0.60	0.20–0.30	....
NE 8735	0.33–0.38	0.70–0.90	0.040	0.040	0.20–0.35	0.40–0.60	0.40–0.60	0.20–0.30	....
NE 8739	0.35–0.40	0.70–0.90	0.040	0.040	0.20–0.35	0.40–0.60	0.40–0.60	0.20–0.30	....
NE 8744	0.40–0.45	0.70–0.90	0.040	0.040	0.20–0.35	0.40–0.60	0.40–0.60	0.20–0.30	....
NE 8749	0.45–0.50	0.70–0.90	0.040	0.040	0.20–0.35	0.40–0.60	0.40–0.60	0.20–0.30	....
NE 8949	0.45–0.50	1.00–1.30	0.040	0.040	0.20–0.35	0.40–0.60	0.40–0.60	0.30–0.40	....
A 4317	0.15–0.20	0.45–0.65	0.040	0.040	0.20–0.35	1.65–2.00	0.40–0.60	0.20–0.30	....
A 4320	0.17–0.22	0.45–0.65	0.040	0.040	0.20–0.35	1.65–2.00	0.40–0.60	0.20–0.30	4320
A 4337	0.35–0.40	0.60–0.80	0.040	0.040	0.20–0.35	1.65–2.00	0.60–0.80	0.30–0.40	....
E 4337	0.35–0.40	0.60–0.80	0.025	0.025	0.20–0.35	1.65–2.00	0.70–0.90	0.23–0.30	....
A 4340	0.38–0.43	0.60–0.80	0.040	0.040	0.20–0.35	1.65–2.00	0.70–0.90	0.20–0.30	4340
E 4342	0.40–0.45	0.60–0.80	0.025	0.025	0.20–0.35	1.65–2.00	0.70–0.90	0.23–0.30	....
A 4608	0.06–0.11	0.40 max.	0.040	0.040	0.25 max.	1.40–1.75	....	0.15–0.25	....
A 4615	0.13–0.18	0.45–0.65	0.040	0.040	0.20–0.35	1.65–2.00	....	0.20–0.30	4615
E 4617	0.15–0.20	0.45–0.65	0.025	0.025	0.20–0.35	1.65–2.00	....	0.20–0.27	....
A 4620	0.17–0.22	0.45–0.65	0.040	0.040	0.20–0.35	1.65–2.00	....	0.20–0.30	4620
E 4620	0.17–0.22	0.45–0.60	0.025	0.025	0.20–0.35	1.65–2.00	....	0.20–0.27	....
A 4621	0.18–0.23	0.70–0.90	0.040	0.040	0.20–0.35	1.65–2.00	....	0.20–0.30	....
A 4640	0.38–0.43	0.60–0.80	0.040	0.040	0.20–0.35	1.65–2.00	....	0.20–0.30	4640
E 4640	0.38–0.43	0.60–0.80	0.025	0.025	0.20–0.35	1.65–2.00	....	0.20–0.27	....
A 4645	0.43–0.48	0.60–0.80	0.040	0.040	0.20–0.35	1.65–2.00	....	0.20–0.30	....
A 4815	0.13–0.18	0.40–0.60	0.040	0.040	0.20–0.35	3.25–3.75	....	0.20–0.30	4815
A 4820	0.18–0.23	0.50–0.70	0.040	0.040	0.20–0.35	3.25–3.75	....	0.20–0.30	4820
A 5045	0.43–0.48	0.70–0.90	0.040	0.040	0.20–0.35	....	0.55–0.75	....	....
A 5120	0.17–0.22	0.70–0.90	0.040	0.040	0.20–0.35	....	0.70–0.90	....	5120
A 5130	0.28–0.33	0.70–0.90	0.040	0.040	0.20–0.35	....	0.80–1.10	....	....
A 5140	0.38–0.43	0.70–0.90	0.040	0.040	0.20–0.35	....	0.70–0.90	....	5140
A 5145	0.43–0.48	0.70–0.90	0.040	0.040	0.20–0.35	....	0.70–0.90	....	....
A 5150	0.48–0.55	0.70–0.90	0.040	0.040	0.20–0.35	....	0.70–0.90	....	5150
A 5152	0.45–0.55	0.70–0.90	0.040	0.040	0.20–0.35	....	0.90–1.20	....	....
E 52095	0.90–1.00	0.30–0.50†	0.025	0.025	0.20–0.35	....	0.45–0.65	....	....
E 52098	0.90–1.05	0.30–0.50†	0.025	0.025	0.20–0.35	....	1.00–1.25	....	....
E 52099	0.90–1.05	0.30–0.50†	0.025	0.025	0.20–0.35	....	1.30–1.65	....	....
NE 52100A	0.95–1.10	0.25–0.45	0.040	0.040	0.20–0.35	0.35 max.	0.40–0.60	0.08 max.	....
NE 52100B	0.95–1.10	0.25–0.45	0.040	0.040	0.20–0.35	0.35 max.	0.90–1.15	0.08 max.	....
NE 52100C	0.95–1.10	0.25–0.45	0.040	0.040	0.20–0.35	0.35 max.	1.30–1.60	0.08 max.	....
E 52100	0.95–1.10	0.30–0.50†	0.025	0.025	0.20–0.35	....	1.20–1.50	....	52100
E 52101	0.95–1.10	0.30–0.50†	0.025	0.025	0.20–0.35	....	1.30–1.65	....	....
E 52107	1.00–1.15	0.30–0.50†	0.025	0.025	0.20–0.35	....	1.35–1.65	....	....
A 6120	0.17–0.22	0.70–0.90	0.040	0.040	0.20–0.35	....	0.70–0.90	0.10 min.V	....
A 6145	0.43–0.48	0.70–0.90	0.040	0.040	0.20–0.35	....	0.80–1.10	0.15 min.V	....
SAE 6150	0.48–0.55	0.65–0.90	0.040	0.040	0.20–0.35	....	0.80–1.10	0.15 min.V	6150
E 6151	0.47–0.53	0.70–0.90	0.025	0.025	0.20–0.35	....	0.80–1.10	0.15 min.V	....
A 6152	0.48–0.55	0.70–0.90	0.040	0.040	0.20–0.35	....	0.80–1.10	0.10 min.V	....
NE 9255	0.50–0.60	0.70–0.95	0.040	0.040	1.80–2.20	....	....	....	....
NE 9260	0.55–0.65	0.75–1.00	0.040	0.040	1.80–2.20	....	....	....	9260
NE 9262	0.55–0.65	0.75–1.00	0.040	0.040	1.80–2.20	....	0.20–0.40	....	....
NE 9415	0.13–0.18	0.80–1.10	0.040	0.040	0.40–0.60	0.20–0.40	0.20–0.40	0.08–0.15	....
NE 9420	0.18–0.23	0.80–1.10	0.040	0.040	0.40–0.60	0.20–0.40	0.20–0.40	0.08–0.15	....
NE 9422	0.20–0.25	0.80–1.10	0.040	0.040	0.40–0.60	0.20–0.40	0.20–0.40	0.08–0.15	....
NE 9430	0.28–0.33	0.90–1.20	0.040	0.040	0.40–0.60	0.20–0.40	0.20–0.40	0.08–0.15	....
NE 9435	0.33–0.38	0.90–1.20	0.040	0.040	0.40–0.60	0.20–0.40	0.20–0.40	0.08–0.15	....
NE 9437	0.35–0.40	0.90–1.20	0.040	0.040	0.40–0.60	0.20–0.40	0.20–0.40	0.08–0.15	....
NE 9440	0.38–0.43	0.90–1.20	0.040	0.040	0.40–0.60	0.20–0.40	0.20–0.40	0.08–0.15	....
NE 9442	0.40–0.45	1.00–1.30	0.040	0.040	0.40–0.60	0.20–0.40	0.20–0.40	0.08–0.15	....
NE 9445	0.43–0.48	1.00–1.30	0.040	0.040	0.40–0.60	0.20–0.40	0.20–0.40	0.08–0.15	....
NE 9450	0.48–0.53	1.20–1.50	0.040	0.040	0.40–0.60	0.20–0.40	0.20–0.40	0.08–0.15	....
NE 9537	0.35–0.40	1.20–1.50	0.040	0.040	0.40–0.60	0.40–0.60	0.40–0.60	0.15–0.25	....
NE 9540	0.38–0.43	1.20–1.50	0.040	0.040	0.40–0.60	0.40–0.60	0.40–0.60	0.15–0.25	....
NE 9542	0.40–0.45	1.20–1.50	0.040	0.040	0.40–0.60	0.40–0.60	0.40–0.60	0.15–0.25	....
NE 9550	0.48–0.53	1.20–1.50	0.040	0.040	0.40–0.60	0.40–0.60	0.40–0.60	0.15–0.25	....
NE 9630	0.28–0.33	1.20–1.50	0.040	0.040	0.40–0.60	....	0.40–0.60	....	....
NE 9635	0.33–0.38	1.20–1.50	0.040	0.040	0.40–0.60	....	0.40–0.60	....	....
NE 9637	0.35–0.40	1.20–1.50	0.040	0.040	0.40–0.60	....	0.40–0.60	....	....
NE 9640	0.38–0.43	1.20–1.50	0.040	0.040	0.40–0.60	....	0.40–0.60	....	....
NE 9642	0.40–0.45	1.30–1.60	0.040	0.040	0.40–0.60	....	0.40–0.60	....	....
NE 9645	0.43–0.48	1.30–1.60	0.040	0.040	0.40–0.60	....	0.40–0.60	....	....
NE 9650	0.48–0.53	1.30–1.60	0.040	0.040	0.40–0.60	....	0.40–0.60	....	....

*Lowest standard maximum phosphorus or sulphur content for acid openhearth or acid electric furnace alloy steel is 0.05% each; silicon is 0.15% min.

†These steels may be specified to either 0.30 to 0.45% or 0.35 to 0.50% manganese, but it is recommended that the full range be allowed wherever possible.

NOTE (a)—Sulphur range: 0.035 to 0.050%.

Steels and Irons

Three Tons of American Steel for each two from the Axis

THE STEEL INDUSTRY of the United States this year will exceed all previous records by producing approximately 85,000,000 tons of steel to meet the urgent needs of war. To realize what that number of tons signifies requires some comparison with the yardsticks of past performance and present capabilities.

Steel production in 1942 will be nearly 70% *greater* than output in the biggest year of World War I, and will surpass by fully one-third the subsequent peacetime peak. Using still another measure of comparison, American steel plants are now producing three tons of steel for every two tons which could be made in all Axis and Axis-dominated countries, even if every steel plant therein could operate uninterruptedly at full capacity.

The current level of steel production could not have been achieved by the plants and facilities available in this country only 30 months ago. At that time, the industry's capacity was slightly less than 82,000,000 tons of steel per year, a figure which might be thought to be ample, since it exceeded by nearly 30% the tonnage which we had ever been actually called upon to produce in any previous year. Realizing, however, the great need for steel in wartime, the steel industry early in 1940 embarked upon a large expansion. Since the outbreak of war in Europe, there has been built more new steel capacity than is available in all of Japan! As of July 1 of this year, the rated capacity of the industry stood at 89,200,000 tons per year — and it is still expanding.

Steel production this year, although destined to establish a new record, will nevertheless fall short of actual capacity by several million tons because of inadequate supplies of metallic raw materials, principally scrap iron and steel. There must therefore be full public cooperation in the present nation-wide drive to bring in more scrap from homes, farms and industries. Only in this way can the tremendous productive potentiality of all American industry be fully utilized for the war effort.

WALTER S. TOWER
President
American Iron and Steel Institute

Steel Plants Fabricate Munitions

THE CONTRIBUTION which Republic Steel Corp. is making to the war effort can best be told briefly by indicating the production records which the corporation is piling up.

All-time records, for instance, were made for the first seven months of 1942, as compared to the first seven months of 1941, in the important divisions of coke, pig iron and steel ingots. Coke output for this period in 1942 was 159,753 tons *more* than for the similar period in 1941. The Corporation's pig iron production jumped well over 100,000 tons beyond the figure for the same seven months of last year, and the steel ingot production for the same period was substantially greater.

New records were set in 123 of the 170 major producing departments in the steel plants and mines between December, 1940 and August 1, 1942. During these 19 months these departments established 421 important *monthly* production records.

Not only are Republic Steel plants working at capacity, but its manufacturing divisions have been converted virtually in their entirety from peace-time to war-time production. In these plants tank treads, invasion barges, airplane rudders, airfield landing mats, anti-aircraft gun parts, bomber motor parts, bombs, tank wheels and a score of other important materials are now in production. In addition, the Corporation's Manufacturing Division is also planning to produce complete fuselages, large demolition bombs, incendiary bombs, anti-aircraft gun carriages, and other war materials. Instead of making the raw steel and shipping it

to others to fabricate, as is usual in the steel industry, the Corporation is now doing the fabrication itself, in these important items.

CHARLES M. WHITE
Vice-President in Charge of Operations
Republic Steel Corp.

Steel Production Records are only something to break

WITH EVERY FACILITY geared for top-speed war production, the plants of Carnegie-Illinois Steel Corp. in recent months have attained the greatest steel tonnage in the history of this subsidiary of United States Steel Corp. Patriotic cooperation of employees, and the utmost utilization of equipment and raw materials, have stepped up production to new all-time records.

Three new blast furnace records were achieved this year, and a month seldom passes that does not find one or more Carnegie-Illinois plants attaining new production marks for pig iron, ingots, or rolled steel products. The company's operating units turned out 1,458,728 tons of blast furnace iron in July for a new all-time record for one month's work.

Plate tonnage of Carnegie-Illinois today is more than three times that possible in 1940, a result of additions to existing mills, conversion of wide strip mills, and the cooperation shown by the production soldiers of 1942. The company for several months has been turning out a far larger share of the entire country's plate production than its proportionate share of the nation's steel making capacity. Both the Irvin Works' and Gary Works' 80-in. continuous sheet mills were converted this year to roll vitally needed ship plate, and substantial new tonnage records have been achieved in these plants. Likewise the company revamped its Farrell tin mills into an important plant for making armor plate for tanks.

One of our sales representatives developed the portable steel runway for airplane landing fields, hailed as one of the outstanding developments in aviation since the start of the war.

To aid in conserving the nation's vital supply of pig tin, Carnegie-Illinois is installing electrolytic tin plating production lines.

Equally noteworthy are the contributions of the research, metallurgical and engineering forces in developing substitutes for restricted materials and assisting in the solution of manufacturing problems. Research work in the company's laboratories has kept pace with the production lines, and there has been a rapid and successful search for accurate information about the many items of steel technology which are especially involved in waging modern warfare.

CARNEGIE-ILLINOIS STEEL CORP.

Strip Steel at Practical Capacity

THERE is nothing particularly glamorous about the operations of a strip mill, and we are therefore unable to report activities of unusual interest. We are at the present time, and have been for months past, operating at practical capacity on the specialty sizes and qualities of cold-rolled strip steel which we produce. Our production has been stepped up somewhat over normal operations but this involves only careful, hard work and the application of some common sense. In common with other American plants, we are simply doing our best to produce the products required of us, in quantities demanded by the war program.

C. M. BEEGHLY
Manager Strip Steel Division
Cold Metal Products Co.

Improved Castings meet many emergencies

THE GREATEST CONTRIBUTION to increased war production being made by the manufacturers of high duty castings such as Meehanite is found in the provision of engineering properties of such a high order that it has been possible to relieve substantially the situation which has been created by shortages among other materials. The backbone of successful mass production in tremendous quantities is to make the most efficient use of suitable and available materials to produce a superior quality product.

Under the conditions imposed by the war production program, men in industry having to do with the selection of materials are faced with extraordinary demands for positive knowledge

concerning what is available and where. Furthermore, these conditions also demand considerable open-mindedness concerning the possible use of one material in place of another which may have been established by long usage, prior to the time when the superior engineering characteristics of present-day high duty castings were available.

During recent months the foundries making such special irons have made every effort to provide and disseminate useful information about them, particularly in cases where bottlenecks had been encountered and where it was a known fact that the improved product could successfully be used in place of materials which might previously have been specified. Help has also been extended to customers in regard to heat treatment, machining, flame hardening and, of course, with regard to the selection of the right type of material for specific service requirements.

The fact that the superior properties available in modern castings are inherent as delivered and are not dependent upon complex and time consuming treatments after delivery has been emphasized to great advantage.

Finally, through diligent attention and adherence to proved production methods, castings are manufactured which are uniform and provide maximum freedom from flaws and defects. In this way lost machining time, irregularity of production, and waste are substantially reduced.

Oliver Smalley
President
Meehanite Metal Corp.

Revival of Converter Cast Steel

THE AMERICAN FOUNDRY INDUSTRY, catapulted into war production, found itself badly organized for the requirements. The bulk of the capacity was for gray and malleable iron, and for this the war program had the least need. On the other hand, more than three times as much cast steel was urgently needed as could possibly be made with existing equipment. Obviously the problem was to aid by all means the conversion of gray iron foundries into steel foundries.

Such conversion required the re-education of management and personnel, and the installation of steel melting and annealing equipment. Three steel-making processes are available, openhearth, electric, and side-blow converter. Even though the first two are preferred by the Services (converter steel has been allowed only by special permission in some specifications), plant for the last mentioned may be readily installed without encountering as many bottlenecks. In fact, over 40 converters have been placed in foundries in the past year.

However, the most important thing that was accomplished this year was an exhaustive test by Battelle Memorial Institute on the comparative properties of steel castings made by the various processes. This report was presented at the 45th annual meeting of the American Society for Testing Materials and is available in preprint form. These tests proved that the converter had been the victim of prejudice for many years and that there is no reason why converter steel, if properly made, is not equal to any other type of steel regardless of the process used. It showed exceptionally good properties at sub-zero temperatures in impact tests. In other words, the quality of steel is not dependent on the process but rather on the care and skill employed.

The significance of this is that the side-blow converter enables the industry to increase its steel production capacity at a lower investment cost than by any other process.

An interesting adaptation of the converter process has been for the economical production of first-class steel from none-too-good raw material (what we can get) in a continuous stream to serve molds on a traveling conveyor, in several of the country's large mass production foundries. Available scrap is melted in existing cupolas, and the metal desulphurized with soda ash in the ladle while being transferred to the converter. The converter blows out the carbon, silicon and manganese; control is by electric eye. Enough 50% ferrosilicon or silvery pig iron is added in the cupola charge to act as fuel in the converter, and to deliver metal of proper temperature to the third furnace in this triplex process, an electric furnace. Here the metal is deoxidized, alloys added, and the steel poured into molds.

A. W. Gregg
Executive Engineer
Whiting Corp.

A Volunteer Industry Reports

LONG before Pearl Harbor the steel castings industry had "enlisted for the duration". It has continuously stepped up its production until today it is turning out about three times the volume which in peace times was considered full capacity. This has been accomplished by working extra shifts, expanding production facilities and balancing departmental equipment to eliminate bottlenecks.

The latest type of combat tanks are built largely of steel castings. Integral, streamlined bodies or hulls of cast armor steel, surmounted by one-piece cast armor steel turrets, make these newest models the best weapons of their kind this country has ever built. The steel foundries pioneered in this improvement in war materiel, working closely with the tank division of Army Ordnance.

Our fighting ships and merchant vessels are using more and more steel castings in their superstructure, deck fittings, and operating machinery. That's because steel castings can be readily repaired by welding on the high seas in case of damage.

Likewise, increasing numbers of airplane and aero engine parts are being made in the steel foundry, many replacing other forms of steel construction.

Cast steel gun mounts — for all types and calibre guns — are being produced in great numbers. From "ack-ack" rifles to monster coast defense guns, steel castings are in there carrying the heavy loads and terrific impacts which must be sustained by the engines of modern warfare.

When old customers experience difficulty in getting steel castings they must remember that the wartime demand is unprecedented. They are being specified for an ever-growing number of applications. Only by determined effort has the industry succeeded in keeping its backlog of orders from steadily increasing.

Taking out just time enough for repairing and maintaining plant and equipment, the foundries of America are working the clock around in a sustained drive to supply the armed forces of the United Nations and to hasten victory.

R. L. Collier
Secretary
Steel Founders' Society of America

Cooperation of Tool Users
invaluable to toolsteel makers

THE TOOLSTEEL INDUSTRY during the past year has completed a further transformation from a 100% defense industry to a 100% war production industry. A year ago it had already converted its operations into 50% production of the molybdenum type of high speed steel and subsequently increased this proportion to 75% and even higher.

Composition and production methods were adjusted to meet the needs of the trade and at the same time total production was increased and has now reached about double the quantity of a year ago. Some grades, especially those containing large amounts or non-essential amounts of vanadium, have been entirely eliminated. Demands for other products, notably hot working steels, have been greatly increased while the need for some of the others has considerably decreased. In the face of expanding tonnage of product the supply of alloys and raw material has been considerably restricted, necessitating a high turnover rate of inventories to meet the needs of the situation.

There has been no major plant expansion in the industry but the removal of bottlenecks, by an extra furnace here and there, and around-the-clock operations have met the demands on the industry. Expanded operations and replacements of men in service have brought new men into the industry. Probably over one-half of all the men working in the industry at this time have had less than a few years' experience with the product — something which "could not be done" a generation ago in the manufacture of these special steels.

Customers' cooperation and resourcefulness have been of the greatest assistance. The ingenuity of the men that control production methods and design the tools has been beyond belief. This is highly appreciated by the toolsteel industry and should also be publicly recognized as an immeasurable contribution to the war production program. Methods, tools and equipment have been adapted in an amazing fashion to the needs of the time, and production on the part of toolsteel users can be truly said to be "over the top".

Arthur T. Clarage
President, Columbia Tool Steel Co.

Balancing Increased Production of Various Types of Toolsteels

INCREASED production of war products in a strictly toolsteel mill must be a balanced increase in high speed, alloy, and carbon toolsteel analyses. By that I mean we cannot simply increase our melting without taking into consideration the hammer and rolling capacity, and balancing the forging with the finishing mill capacity — as some grades of high speed steel must not be allowed to get below a red heat before charging in the heating furnace to bring up to the forging temperature. Therefore, increasing the production at our plants is a complex problem.

However we can give a very satisfactory picture of our successful efforts to produce more high speed tool and die steels by the statement that in the year 1937, which was considered a "high production" year, our production was only about one-third of the tonnage we will show for the year 1942. These products will be for the Army, Navy and Air Forces. Besides the production for United States' services, we have on our books orders for Great Britain, Russia and China.

Shortage of strategic materials has been a serious handicap to full operation. The training of skilled men is also a greater problem in a toolsteel mill than in a tonnage mill. We have tried to meet our ever-increasing problems by increased hours and efficient supervision, and we can be counted upon to continue our 100% war program with further increases wherever possible.

Floyd Rose
Vice-President
Vanadium-Alloys Steel Co.

Never a Dull Moment

THE EDITOR asks how we are doing. We've been working to beat hell! We are shipping twice as much steel as we ever dreamed of making two years ago, and that is not nearly enough. In the late summer, even as this is being written, it is evident that materials are to be the crux of the war program, and it takes every ounce of energy to get out the maximum quantity in the shortest possible time.

To be sure there have been many changes and developments in product; a constant struggle to conserve nickel, chromium, and vanadium by using leaner alloys or eliminating them altogether; the development of special shapes and other finished forms to save fabricating steps in the building of war equipment.

Contrary to traditional beliefs, the quality of specialty steels as measured by the rigidity of specifications, the severity of tests, and the accuracy of finish have improved rather than suffered during the past months of frantic production! Workmen and foremen in our mills are really "doing the impossible" when they know that it will shorten the steps to the final delivery of some piece of necessary apparatus to Uncle Sam's forces.

This much is sure — there has never been a dull moment!

Frank R. Palmer
Vice-President in Charge of Sales
The Carpenter Steel Co.

Increasing Production; Helping Others

EARLY IN 1940, Allegheny Ludlum Steel Corp. began the expenditure of several million dollars in an expansion and modernization program at all of its own mills and those of its subsidiary companies. New electric furnace capacity and finishing mill equipment were installed; existing production facilities were overhauled to step up output. Although improvements are still going on in each of the company's mills, the major units in this initial expansion program were completed by mid-1941, more than a year ago, and beneficial results are now in evidence.

While 1940 production had set a new high mark for the company, its 1941 shipments were a full third greater. Average monthly value of Allegheny Ludlum's shipments of its special steels in 1941 was \$7,500,000, but by July, 1942, shipments had been boosted to \$9,000,000 monthly, a further increase of 20% over the 1941 average in only 7 months' time. Special "war production" drives, currently going into effect, are expected to push this figure even higher before the end of 1942. For months past, of course, the company has been 100% on war production.

Shifts in management have been made, and additional top executives created, to match the upward surge of output. All our plants in the Pittsburgh area were placed under unified management in late 1940. In early 1941, a new Development Engineering Department was created, followed shortly by a special Scrap and Salvage Department — both undertaking highly essential liaison work with war industries in their respective fields.

In addition to the expansion of its own production, Allegheny Ludlum has paid considerable attention to assisting its customers in using its products to the best advantage, through the medium of new pamphlets, instruction sheets and moving pictures, and by lecture tours arranged for a number of its metallurgists and technical experts. This work is currently being accelerated.

H. G. Batcheller
President
Allegheny Ludlum Steel Corp.

Cooperation With Armed Services

Enlistment into the armed services of the entire stainless steel productive capacity of United States Steel Corp.'s subsidiary, Carnegie-Illinois Steel Corp., dates back to the very beginning of the emergency, long before Pearl Harbor. One of the primary efforts of the Carnegie-Illinois' stainless steel division was the effort to standardize the specifications under which this vital alloy was bought by the Army and Navy. Working out this program with the specification groups of the Army and Navy as well as the Federal Specification Board (which covered munitions, ship construction, and aircraft) the requirements of the various branches were brought into uniformity and the number of analyses reduced to a minimum. As a result, the stainless steel productive capacity — from melting through to the finished product — was maintained at maximum efficiency.

Representatives of the stainless steel division have consistently endeavored to suggest the use of suitable alternate materials, both in existing designs where high chromium and chromium-nickel steels have been used, and in new designs where such use is contemplated, in order that maximum conservation of these strategic alloy materials may be maintained. Where the use of stainless steel is found to be imperative, assistance is given in the proper fabrication and use so as to eliminate spoilage.

Assistance in recommending proper design and fabrication of aircraft parts — as for example, fire walls and exhaust systems wherein stainless steel can play the important part that it has in the aircraft program — is an important phase of Carnegie-Illinois' activity in this field. Representatives of the company have worked closely with the Army and Navy engineering and ordnance groups in adapting efficient use of stainless steel in such problems as acid plant, powder plant, chemical warfare, and similar equipment requirements.

Carnegie-Illinois Steel Corp.

Chromium Recovered From Ore and Stainless Scrap

During the past year the entire output of the stainless steel industry has been directed to war uses. Stainless steel has contributed greatly to the efficiency of our war materiel, and is now listed with the most critical of materials.

To aid in the production of war products Rustless Iron and Steel Corp. has increased its ingot capacity substantially, and otherwise expanded its production of stainless steels. During the same period its subsidiary, Rustless Mining Corp., also placed in operation at its Grey Eagle property in California a modern 200-ton concentrating plant for the production of chrome ore concentrates.

The new melting unit is a 25-ton Heroult furnace, bringing to six the number of electric furnaces at the Baltimore plant. Rustless is making a major contribution toward the conservation of chromium and nickel by virtue of its special melting process, which utilizes large proportions of stainless steel scrap, regardless of how low the specified carbon content may be. At the same time the process utilizes a submetallurgical grade of chrome ore, directly, to the extent of approximately half of the chromium contained in the ingot. A further step in conservation of strategic metals has been achieved through the recovery of metal values from stainless steel grinding dust. Major

improvements in the descaling and pickling of stainless steel have also been realized.

For the purpose of exerting a more rapid and complete control of residual impurities in steel scrap, and for the purpose of expediting certain routine chemical control analysis, equipment has been installed for spectochemical analysis.

A. L. Feild
Technical Director
Rustless Iron and Steel Corp.

Silicon-Iron Equipment Essential
for many of the new synthetics

Use of the two high-silicon irons known as Duriron and Durichlor has been greatly accelerated. It is natural that the increased production of chemicals, steel, fine metals, fertilizer and pharmaceuticals, where these alloys have been used for 30 years, would create an increased demand; in addition to such uses normal to peacetime, these alloys have found new and extended applications in the production of war supplies.

Explosive manufacture presents the problem of denitrating mixed acids and subsequent concentration of the sulphuric acid. Duriron (14½% silicon-iron) is one of the few alloys that will satisfactorily resist corrosion when denitrating mixed acid, and resist sulphuric acid at the temperatures and strengths present when concentrating it. The alloy is also being successfully used in the manufacture of synthetic rubber, many of the new vitamin concentrates, high octane gas, and magnesium metal.

Durichlor (14½% silicon-iron with a molybdenum addition) is used for many of the chlorine solutions in producing some new war chemicals; also for similar solutions in the manufacture of synthetic rubber, particularly the chlorinated types, and in several of the butadiene processes. High octane gas, produced by processes involving hydrochloric acid and other chlorides, has opened new applications for this alloy. Magnesium chloride solutions with free hydrochloric acid, as encountered in the production of magnesium, are also successfully handled by Durichlor.

D. E. Jack
General Sales Manager
The Duriron Co.

Molybdenum — The American Alloy

Due to the fact that much molybdenum is obtained as a by-product of copper mining operations any major increase in its production for the war effort has necessarily been a result of the expansion program of the Climax Molybdenum Co., at its mine in Colorado and its converting plant in Pennsylvania. Western production has been briefly described by The Editor of Metal Progress in his "Critical Points" in July and August of 1941.

In 1940, plans were made to bring the mining operations in Colorado to the physical limits of the ore body. These efforts, over a period of two years, have resulted, early in 1942, in the achievement of the maximum production possible of ore and of molybdenum sulphide concentrates therefrom.

In 1941 two additional large roasters were installed in our converting plant in Pennsylvania with the result that Climax is now converting molybdenum into products usable by the iron and steel industry at double the rate of its maximum capacity in early 1941. As a result of this and other increases in converting capacity in the country, the industry can now convert into usable products all molybdenum ore mined in the Western hemisphere. This put it in excellent position for the first "metallurgical conversion" job, namely, the substitution of molybdenum for a large part of the tungsten in high speed cutting tools.

However, due to the fact that most other alloying elements for iron and steel went on the critical list over a year ago, the demands for molybdenum have increased so rapidly that it also developed a potential shortage in supply, and its use is now under full allocation through the War Production Board's General Preference Order M-110.

As a result of the enormous increase in production of alloy steels and the shortage of alloying elements, a committee was organized by the War Production Board called "Technical Committee for Carbon and Alloy Bar, Billet, Bloom and Slab and Cold Finished Products", to devise some new steels which would make the effective use of the most easily available alloying elements, and especially the minor percentages now existing in the available scrap steel. This committee has proposed for this

purpose a series of "National Emergency Steels", the NE 8000 series, which have received wide publicity, all of which contain significant percentages of molybdenum, and which, with the plain carbon steels, the carbon-manganese steels, and the carbon-molybdenum steels A.I.S.I. 4000 series, are believed to be capable of furnishing every engineering requirement except for specialized purposes where resistance to heat, erosion and corrosion are paramount. Study of these steels, under the direction of L. E. Ekholm (Alan Wood Steel Co.), is being done by many laboratories and is being correlated, summarized and put into statistical form by the Climax Molybdenum Co.'s research department in Detroit.

This represents the broad picture of how molybdenum, a rare element during the last war, is an essential ingredient of steel in the present emergency.

Carl M. Loeb, Jr.
Vice-President
Climax Molybdenum Co.

Chromium Reserves Greatly Increased

No earlier than 1938 the Chromium Mining & Smelting Corp. started commercial production in a Canadian plant of chromium from low grade ore. Whereas the former electric furnace production of ferrochromium in standard grades required an ore containing at least 3.2 times as much chromium as iron, our new process is in steady operation on ores containing a chromium-iron ratio of 1.7 to 1. Thus it is applicable to ores available in great tonnage in North America, whereas all the supplies for ferrochromium have previously been imported from long distances overseas, and it required about 4 tons of high grade ore to produce 1 ton of chromium.

In order to help meet the very large current demands for chromium the Corporation has improved its plant facilities to double its output. The products, high carbon and low carbon "Chrom-X", are now widely accepted and highly desired for the production of chromium steels and irons in the United States, Canada and England. Production in our plant will shortly reach a rate about equal to 10% of the 1941 consumption in America, and all of it will be directly smelted from ores otherwise unusable without expensive preliminary concentration or other treatment.

During the year the Chromium Mining and Smelting Corp. has also completed the development of two economical processes for the beneficiation of low grade chromite ores, or concentrates with a low chromium-to-iron ratio. They produce a high grade material from which standard ferrochrome can be produced by conventional electric furnace methods.

Marvin J. Udy
Vice-President
Research and Development
Chromium Mining & Smelting Corp.

More Alloys, Better Used

During the last year the unprecedented demands placed upon the steel companies have naturally reflected themselves in the great increase in the use of alloys of all types. To do its part in meeting the requirements, Molybdenum Corp. of America has increased its molybdenum production capacity almost twice, and has under construction additional facilities that will mean another 50%.

During the same period we have nearly doubled our capacity to produce tungsten in metallurgical grade.

These increases in plant capacity, while keeping up production when practically all raw materials were under priority, oftentimes present almost overwhelming obstacles. Our mining engineers have been searching far and near to find additional mining properties; this has been accomplished. During the last three years our research department has also been working continuously on the use of boron in steel in extremely minute quantities. These efforts have been highly successful and are resulting in the saving of large quantities of other strategic alloying elements in steel.

Through this period of great activity we feel that we have come to know our customers and competitors better. The fine spirit of cooperation and patriotism shown on both sides is most heartening.

William H. Phillips
Vice-President
Molybdenum Corp. of America

Nickel Helps the United Nations' War Effort

UNITED NATIONS' requirements for nickel are being supplied almost entirely through the facilities of The International Nickel Co. Upon the entrance of Great Britain and Canada into the war, production was increased to full capacity. With the initiation of the United States' rearmament and the lend-lease program it became evident that increased production would be necessary. Plans were made and put into effect to increase the yearly nickel production capacity of the Company by 50,000,000 lb. With production facilities already streamlined this meant expanding the entire line of operations, opening new ore bodies, sinking shafts, developing the mines, installing new machinery and enlarging facilities for all subsequent operations, such as ore concentration, smelting and electrolytic refining. This project was under way before Pearl Harbor; production is now increased, but the full benefit will be effective in 1943.

We have assisted further by refining the mine production of other companies, including Falconbridge Nickel Mines, Ltd. These materials have been treated in sufficient volume to require the installation of new refining facilities both in Canada and the United States. Remelting of scrap material into useful forms has also been undertaken at the request of the Metals Reserve Corp. Substantial aid has been given this agency in the collection of nickel anodes, nickel scrap and salts from the nickel plating industry, and diversion of this metal into more active channels.

Additional supplies of primary nickel from even other sources, it should be noted, are expected to become available during the coming year, principally from deposits now under development in Cuba.

It has been recognized that nickel in scrap is increasingly becoming a major factor in the current supply of nickel and, indeed, it has been stated that nickel available from this source, if returned to the raw material producer in usable form, would equal the output of a good size nickel mine in replacing primary nickel. It has been estimated that 2½ times as much nickel in scrap is now being received by steel mills as at this time last year, whereas the rate of production of nickel-bearing steel is approximately 38% greater. There is no doubt that the proportion of nickel contained in returning scrap and used in the total melt is larger than a year ago. Definite figures are not available, but there is evidence to indicate that many plants could greatly increase their consumption of such nickel steel scrap.

Conservation measures have played an important role in the nickel situation and industries using nickel steel and other products have cooperated with the Government by increasing the flow of scrap back to the mills. Manufacturers have altered their practices and reduced their requirements of nickel to a minimum. Assistance has been rendered by the Company's technical staff and field office personnel to nickel-consuming industries in their production of war and essential products, particularly in connection with the changes in the materials which are available and on the utilization of nickel at its greatest efficiency. Our research facilities have been devoted almost entirely to solving problems arising from the war effort, both through Government departments as well as manufacturers engaged in direct production of war materials.

THOMAS H. WICKENDEN
Assistant Manager
Development and Research Division
The International Nickel Co., Inc.

Pearlitic Malleable Irons

BULLETIN No. 1213, Canadian Bureau of Mines, discusses the application of malleable irons in the war effort, and three varieties of pearlitic malleable made in large tonnage in the United States were briefly described:

"Promal", a product of Link-Belt Co., Indianapolis, Ind., was one of the first made. Its tensile strength is 70,000 to 75,000 psi. and elongation 14 to 10%; carbon recombined is between 0.30 and 0.40% (by increasing this, tensile strength goes up to 85,000 to 90,000 psi. and by suitable alloy additions to over 100,000 psi.). Its largest use is for elevating, conveying, and power transmitting chains, but also for items requiring higher strength and good wearing characteristics, some of which were formerly either forgings or steel castings.

"ArmaSteel" (arrested malleableized steel), a product of Saginaw Malleable Iron Division of General Motors Corp., is of standard duplexed blackheart malleable composition with the desired amount of combined carbon retained by interrupting the graphitization. Combined carbon is present as a sorbitic structure and also as minute spheroids of carbide. When heat treated, martensite, or some other form of decomposition product of austenite, will be produced. It possesses excellent wear characteristics and has been selectively hardened either by the Tocco process, flame hardening, or by quenching from a salt bath. Its tensile strength is 65,000 to 90,000 psi., elongation 6 to 3%, and Brinell hardness 143 to 241. It has replaced steel forgings for camshafts and rocker arms in automotive and diesel engines, and has given remarkable service in diesel pistons.

"Z-Metal" manufacture is licensed by Ferrous Metal Corp. of New York. It uses retarding elements, added to the molten metal. It also derives its physical properties from the retention of combined carbon and its physical condition (microstructure). By adjusting the heat treatment and varying the alloy content, a wide range of physical properties can be obtained — tensile strength from 70,000 to 90,000 psi. and Brinell hardness from 155 to 225. When selective hardening is to be performed, an addition of molybdenum is recommended. Z-Metal has replaced normal malleable and other types of ferrous materials in many applications in railway, automotive, fittings, machine parts and tool industries, and in ordnance material such as pistol and gun parts and shell casings.

Specific Effects of Alloys in Steel

Element	Solid Solubility		Influence Upon Ferrite	Influence Upon Austenite (Hardenability)	Influence Exerted Through Carbide		Principal Functions
	In Gamma Iron	In Alpha Iron			Carbide Forming Tendency	Action During Tempering	
Aluminum Al	1.1% (Increased by C)	30% ±	Hardens considerably by solid solution	Increases hardenability mildly, if dissolved in austenite	Less than Fe (Graphitizes)	......	1. Deoxidizes efficiently 2. Restricts grain growth (by forming dispersed oxides or nitrides) 3. Alloying element in nitriding steel
Chromium Cr	12.8% (20% with 0.5% C)	Unlimited	Hardens slightly; increases corrosion resistance	Increases hardenability moderately, similarly to manganese	Greater than Mn; Less than W	Mildly resists softening	1. Increases corrosion and oxidation resistance 2. Increases hardenability 3. Contributes some strength at high temperatures 4. Resists abrasion and wear (with high carbon)
Cobalt Co	Unlimited	80% ±	Hardens considerably by solid solution	Decreases hardenability as dissolved	Similar to Fe	Sustains hardness by solid solution	1. Contributes to red hardness by hardening ferrite
Manganese Mn	Unlimited	15 to 18%	Hardens markedly; reduces plasticity somewhat	Increases hardenability moderately, similarly to chromium	Greater than Fe; Less than Cr	Very little, in usual percentages	1. Counteracts embrittlement by inevitable sulphur 2. Increases hardenability inexpensively 3. Forms batter resistant steel (high Mn, high C)
Molybdenum Mo	3% ± (8% with 0.3% C)	32% (Less with lowered temperature)	Provides age-hardening system in high Mo-Fe alloys	Increases hardenability strongly (Mo > Cr)	Strong; Greater than Cr	Opposes softening, by secondary hardening	1. Raises coarsening temperature of austenite 2. Deepens hardening 3. Raises hot strength, creep resistance, red hardness 4. Enhances corrosion resistance in stainless 5. Forms abrasion-resisting particles
Nickel Ni	Unlimited	25% ± (Irrespective of carbon content)	Strengthens and toughens by solid solution	Increases hardenability mildly, but tends to retain austenite with higher carbon	Less than Fe (Graphitizes)	Very little in small percentages	1. Strengthens unquenched or annealed steels 2. Toughens pearlitic-ferritic steels (especially at low temperature) 3. Renders high chromium-iron alloys austenitic
Phosphorus P	0.5%	2.5% (Irrespective of carbon content)	Hardens strongly by solid solution	Increases hardenability, similarly to manganese	Nil	......	1. Strengthens low carbon steel 2. Increases resistance to corrosion 3. Improves machinability in free-cutting steels
Silicon Si	2% ± (9% with 0.35% C)	18.5% (Not much changed by carbon)	Hardens with loss in plasticity (Mn < Si < P)	Increases hardenability more than nickel (Ni < Si < Mn)	Negative (Graphitizes)	Sustains hardness by solid solution	1. Used as general purpose deoxidizer 2. Alloy for electrical and magnetic sheet 3. Improves oxidation resistance 4. Increases hardenability of steels carrying non-graphitizing elements 5. Strengthens low alloy steels
Titanium Ti	0.75% (1% ± with 0.20% C)	6% ± (Less with lowered temperature)	Provides age-hardening system in high Ti-Fe alloys	Probably increases hardenability very strongly, *as dissolved*. Its carbide effects reduce hardenability	Greatest known (2% Ti renders 0.50% carbon steel unhardenable)	Persistent carbides probably unaffected. Some secondary hardening	1. Fixes carbon in inert particles (a) Reduces martensitic hardness and hardenability in medium chromium steels (b) Prevents formation of austenite in high chromium steels (c) Prevents localized depletion of chromium in stainless steels during long heating
Tungsten W	6% (11% with 0.25% C)	32% (Less with lowered temperature)	Provides age-hardening system in high W-Fe alloys	Increases hardenability strongly in small amounts	Strong	Opposes softening by secondary hardening	1. Forms hard, abrasion resistant particles in toolsteels 2. Promotes red hardness and hot strength
Vanadium V	1.5% ± (4% with 0.20% C)	Unlimited	Hardens moderately by solid solution	Increases hardenability very strongly, *as dissolved*	Very strong (V < Ti or Cb)	Maximum for secondary hardening	1. Elevates coarsening temperature of austenite (promotes fine grain) 2. Increases hardenability (when dissolved) 3. Resists tempering and causes marked secondary hardening

Revised, 1942. Adapted from "The Functions of the Alloying Elements in Steel" by Edgar C. Bain; published by

Help Them Win...Turn in Your SCRAP!

Scrap is steel or iron useless in its existing form but valuable as *raw material* for remelting. Since it is already refined, more scrap in the furnace charge speeds up the refining process and enables steel to be turned out faster for implements of war . . . More scrap—*from your plant*—means more steel.

Conservation Authorities Recommend the Following 8 Steps

1. Put some one individual in charge of scrap in all departments of your business and GIVE HIM AUTHORITY TO ACT.

2. Comb the plant and yards for dormant scrap, abandoned equipment, old boilers, pipe, moulds, obsolete dies and parts, material now being destroyed which has salvage value.

3. Survey all plant equipment, particularly idle standby or discarded machines, with a view to applying or converting them to useful production.

4. SEGREGATION: Identify, classify and segregate scrap and supervise its handling to avoid contamination. This will increase its value. Provide separate containers, clearly marked for each class of scrap material.

Repair or rework worn or broken cutting tools. Keep unusable small pieces and turnings segregated. Even high speed steel grinding dust is valuable.

Dismantle discarded equipment promptly into its components — electrical, fastenings, lumber, etc. — so that these parts may be utilized or scrapped.

Sort blanks, short ends, cut-downs, clippings, etc., for possible reuse for smaller parts made in the same or other departments.

Recover and reclaim used cutting oils, lubricants, surplus paints and spray finishes.

Sort sweepings and miscellaneous waste to recover scrap values.

5. Constant reminders in the form of posters, illustrations of right and wrong methods, pay envelope enclosures, house organ publicity, etc., are potent aids to the conservation program.

6. Release for scrap, obsolete engravings, electrotypes, and standing types for catalogs, forms and advertising material.

7. Inspect all refuse to detect avoidable waste and excessive rejections. Educate production executives to correct such conditions at the source.

8. For information and assistance on special phases of conservation and salvage communicate with Industrial Salvage Section, Conservation Division, War Production Board, 9th Floor, Washington Gas Light Building, Washington, D. C., or with nearest regional office.

The metallurgical experience of our technical staff is available to aid you in these and other technical phases of metal salvage.

KEEP SCRAP MOVING INTO WAR PRODUCTION!

THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK, N. Y.

Toolsteels Classified by Wear-Toughness Ratio

By Harold B. Chambers (See Metal Progress, June 1940, for Its Use as a Tool Selector)

Each of the three groups arranged in order of increasing toughness and decreasing wear resistance. Figures indicated as max. are optional and may be present up to amount noted. Since the difference in relative wear-toughness capacities of adjacent classes is small to negligible, the many brands covered by each class may be expected to give competitive performance except when highly standardized operating conditions require that consideration be given to the footnotes.

Class	Conventional Type Names	Carbon	Manganese	Silicon	Tungsten	Chromium	Vanadium	Molybdenum	Cobalt	Nickel	Notes
	Water Hardening Steels										
1A	Tungsten finishing	1.25-1.50	0.15-0.35	0.15-0.50	2.50- 6.00	1.80 max.	0.30 max.	0.50 max.			A,B,C
1B	Carbon or carbon-vanadium	1.30-1.45	0.15-0.35	0.15-0.35		0.35 max.	0.30 max.				A,C
2A	High carbon, low tungsten	1.10-1.30	0.15-0.35	0.15-0.35	1.00- 2.50	0.35 max.	0.30 max.				A,B
2B	Low chromium or chrome-vanadium	1.10-1.30	0.15-0.35	0.15-0.35		0.10- 1.20	0.30 max.				A,C
2C	Carbon or carbon-vanadium	1.10-1.30	0.15-0.35	0.15-0.35			0.30 max.				A
3A	High carbon, low tungsten	0.90-1.10	0.15-0.35	0.15-0.35	1.00- 2.50	0.75 max.	0.30 max.				A,B,C
3B	Low chromium or chrome-vanadium	0.90-1.10	0.15-0.35	0.15-0.35		0.10- 1.50	0.30 max.				A,C
3C	Carbon or carbon-vanadium	0.90-1.10	0.15-0.35	0.15-0.50			0.50 max.				A,D
4A	Chrome-molybdenum or chrome-vanadium	0.55-0.90	0.15-0.35	0.15-0.35		0.40- 1.20	0.35 max.	0.25 max.		0.50 max.	A,C
4B	Carbon or carbon-vanadium	0.70-0.90	0.15-0.35	0.15-0.35			0.30 max.				A
4C	Silico-manganese or silico-molybdenum	0.45-0.75	0.35-1.00	0.75-2.25		0.60 max.	0.35 max.	0.60 max.			A,E
	Oil Hardening and Air Hardening Steels (Tools of Intricate Design)										
5A	High carbon, high chromium	1.80-2.50	0.15-1.20	0.15-1.00	2.00 max.	10.50-14.00	1.25 max.	0.30 max.	1.00 max.	1.00 max.	A,F,G
5B	High carbon, high chromium	1.80-2.40	0.15-0.60	0.15-0.50		10.50-14.00	1.20 max.	0.70- 1.00	0.60 max.		A,F,G
5C	High carbon, high chromium	1.30-1.70	0.15-0.60	0.15-0.50		10.50-14.00	1.20 max.	0.50- 1.25	4.00 max.	1.00 max.	A,F,G
5D	High carbon, high chromium	1.10-1.40	0.15-1.20	0.15-1.10		5.00-13.00	0.75 max.	0.70- 1.50	0.60 max.		A,F,G
6A	Chrome-molybdenum	1.10-1.30	0.35-0.95	0.15-0.35		0.40- 1.75		0.25- 0.75			A,E
6B	High carbon, low tungsten	1.10-1.30	0.15-0.70	0.15-0.35	1.00- 2.50	0.35- 1.25	0.30 max.				A,B,C
6C	Low chromium or chrome-vanadium	1.10-1.30	0.35-0.70	0.15-0.35		0.40- 1.50	0.30 max.				A,C
7A	Cr-Mo, Mn-Cr, or Mn-Mo non-deforming	0.80-1.10	0.35-3.25	0.15-1.00		0.80- 5.50	0.50 max.	0.75-1.75			A,E
7B	Chromium non-deforming	0.90-1.10	0.35-1.10	0.15-0.50	1.10 max.	0.90- 1.60	0.30 max.	0.50 max.			A,E
7C	Manganese non-deforming	0.80-1.10	0.85-1.80	0.15-0.50	0.70 max.	0.90 max.	0.30 max.	0.35 max.			A,E
8A	Low tungsten-chromium	0.40-0.65	0.15-0.35	0.15-1.50	0.75- 3.00	0.50- 2.00	0.50 max.	0.35 max.		1.50 max.	A,E
8B	Chrome-nickel or chrome-nickel-molybdenum	0.50-0.80	0.35-0.90	0.15-0.35		0.50- 1.25	0.30 max.	0.80 max.		1.00-2.50	A,E
8C	Chrome-molybdenum, chrome-vanadium, or manganese-molybdenum	0.50-0.90	0.35-0.90	0.15-0.50		1.20 max.	0.35 max.	0.40 max.		0.50 max.	A,E
8D	Silico-molybdenum	0.45-0.60	0.35-1.25	0.75-2.25	0.50 max.	0.75 max.	0.60 max.	0.15- 2.20			A,E
	High Speed (H.S.) Steels and Hot Work (H.W.) Steels (Tools Which Heat Up)										
9A	Tungsten-cobalt high speed	0.65-0.90	0.15-0.35	0.15-0.50	18.00-23.00	3.50- 4.75	1.00-3.00	1.25 max.	9.00-15.00		A,G,H
9B	Tungsten-cobalt high speed	0.65-0.90	0.15-0.35	0.15-0.50	17.00-21.00	3.50- 4.75	1.00-2.50	1.25 max.	5.00- 9.00		A,G,H
9C	Tungsten-cobalt high speed	0.65-0.80	0.15-0.35	0.15-0.50	17.00-20.00	3.50- 4.75	0.75-1.50	1.00 max.	2.00- 5.00		A,G,H
9D	Tungsten-cobalt high speed	0.65-0.85	0.15-0.35	0.15-0.50	12.00-15.00	3.50- 4.75	1.00-2.25	0.75 max.	3.00- 8.00		A,G,H
9E*	Molybdenum-cobalt H.S.	0.75-0.95	0.15-0.35	0.15-0.50	6.50 max.	3.50- 4.75	1.00-2.50	4.00-10.00	2.00- 9.00		A,G,H
10A	18-4-4 and 18-4-3 high speed	0.90-1.30	0.15-0.35	0.15-0.50	17.00-19.00	3.50- 4.75	2.50-4.25	1.00 max.			A,H
10B	18-4-2 high speed	0.75-0.90	0.15-0.35	0.15-0.50	17.00-19.00	3.50- 4.75	1.50-2.50	1.00 max.			A,H
10C	18-4-1 high speed	0.55-0.80	0.15-0.35	0.15-0.75	16.00-21.00	3.50- 4.75	0.50-1.50				A,H
10D	14-4-2 and 14-4-1 high speed	0.55-0.80	0.15-0.35	0.15-0.50	13.00-15.00	3.50- 4.75	0.75-2.25				A,H
10E*	Mo-W or Mo-V high speed	0.65-1.30	0.15-0.35	0.15-0.50	6.50 max.	3.50- 4.75	0.75-4.25	4.00- 9.50			A,H
11A	Low carbon high speed	0.45-0.60	0.15-0.35	0.15-0.35	16.00-19.00	3.00- 4.50	0.50-1.25				A,H,I
11B	High tungsten hot work	0.25-0.60	0.15-0.35	0.15-0.35	12.00-16.00	2.50- 4.50	0.75 max.	2.50 max.		3.00 max.	A,H,I
11C	Tungsten hot work	0.25-0.50	0.15-0.35	0.15-0.35	8.00-12.00	1.25- 3.50	0.60 max.	1.00 max.	2.00 max.	2.25 max.	A,H,I
11D*	Mo, or Mo-W hot work	0.30-0.65	0.15-0.35	0.15-1.75	3.00 max.	2.00- 5.50	1.25 max.	2.50 -9.00		1.75 max.	A,H,I
11E	Tungsten-chromium H.W.	0.30-0.60	0.15-0.75	0.35-1.75	4.00- 7.50	4.50- 7.50	0.60 max.	1.00 max.	0.60 max.	0.50 max.	A,H,I
12A	Chrome-molybdenum H.W.	0.30-0.60	0.15-1.25	0.80-1.10	1.75 max.	4.00- 7.50	0.50 max.	0.45- 3.00	0.60 max.	2.00 max.	A,H
12B	Low tungsten-chromium H.W.	0.35-0.65	0.15-0.80	0.15-1.10	1.50- 4.25	0.75- 3.50	0.50 max.	0.60 max.		1.50 max.	A,H
12C	Chrome-molybdenum H.W. or chromium hot work	0.30-1.00	0.15-0.75	0.15-0.75	1.00 max.	2.25- 4.50	1.00 max.	1.00 max.		0.50 max.	A,H
12D	Cr-Ni, or Cr-Ni-Mo hot work	0.25-0.60	0.15-1.00	0.15-0.35		0.50- 2.50	0.30 max.	1.25 max.		1.25-5.00	A,H

A. Wear resistance increases and toughness decreases as carbon content increases.

B. Wear resistance increases and toughness decreases as tungsten content increases.

C. Hardenability increases, wear resistance increases, toughness decreases, movement in hardening decreases, and tendency for soft spots in hardening decreases as chromium increases.

D. Some special applications (silverware striking dies, certain header dies, etc.) may occasionally require extra penetration of hardness, which may be produced by adjusting manganese and silicon contents.

E. Hardenability increases, wear resistance increases and toughness decreases as total alloy content increases.

F. Machining difficulties increase as total alloy content increases.

G. Red hardness properties increase and toughness decreases as cobalt content increases.

H. Red hardness properties increase and toughness decreases as total alloy content increases.

I. Water cooling surface in operation, particularly when intermittent, tends to promote heat checking approximately in proportion to tungsten and/or molybdenum content.

*Not divided into classes. The relative position of a specific molybdenum steel is just below its tungsten steel counterpart. The tungsten counterpart is indicated by adding twice the molybdenum content to the tungsten in a molybdenum steel having 0.05-0.10% higher carbon than the tungsten steel.


"BALL OF FIRE"

Dry Blast for Blast Furnaces*

By David Wolochow

INTEREST in dry blast is now high because it may be the quickest and most economical way to get more pig iron. Whether it is or not cannot readily be determined either from the record or from the claims of various interested firms having processes to sell.

Following some earlier proposals and even trials with blast dried by chemical absorbers James Gayley installed in 1904 a refrigeration system at the Isabella furnaces of the Carnegie Steel Co. near Pittsburgh. This was rapidly followed by dry-blast plants based on Gayley's system at about a dozen furnaces, including two in the Hamilton plant of Steel Co. of Canada. In 1910 a calcium chloride dryer was installed at the Differdange Works, Luxemburg. But in 1913 it was reported that the Gayley plant at the Deutscher Kaiser Works was unsatisfactory, and by 1916 most dry-blast plants were discontinued. However, in 1922, Reese reported that the dry-blast plant at Cardiff had been operating for 13 years.

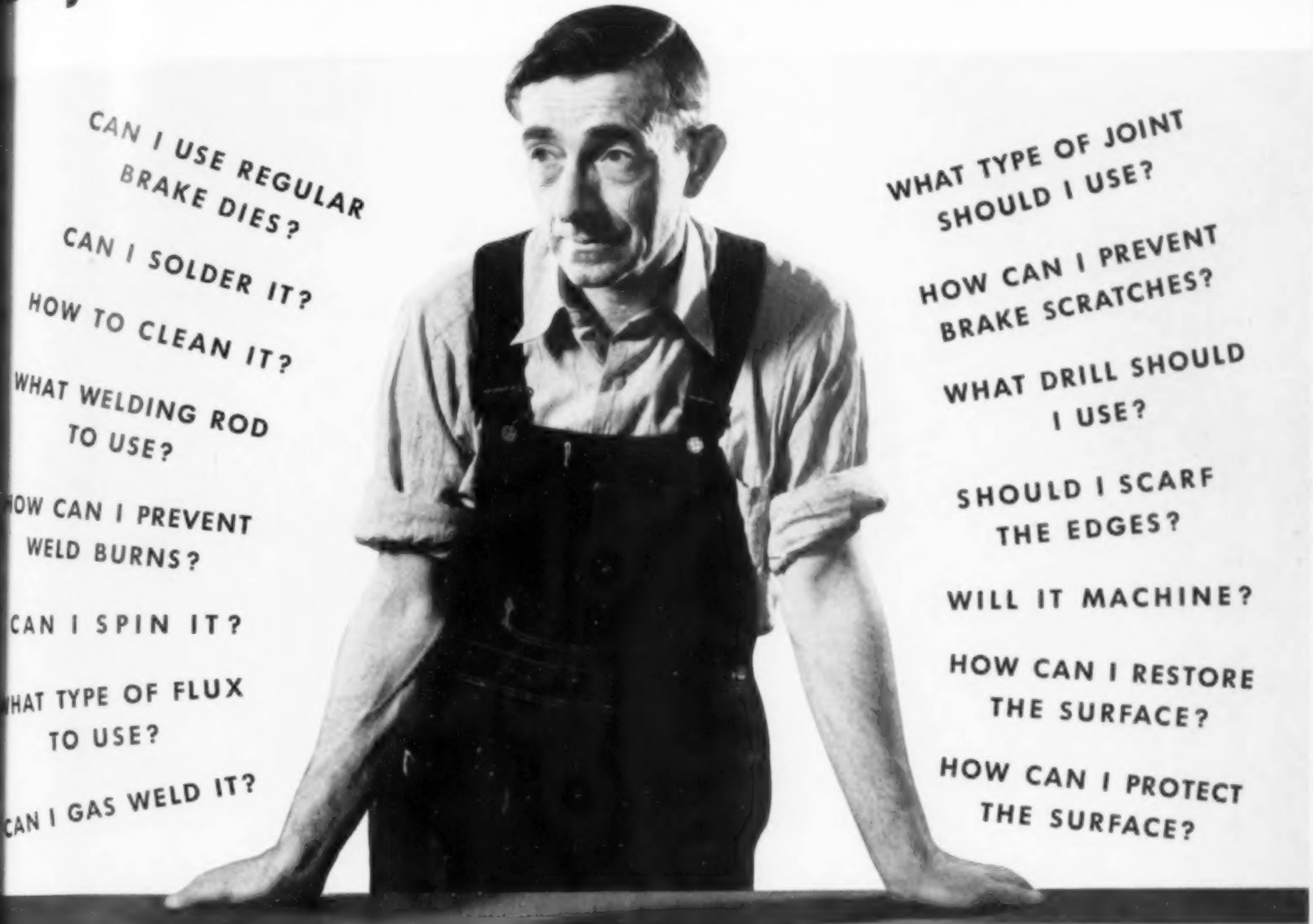
On the face of this brief historical statement it would appear that the dry-blast idea had been given an extensive trial under a wide variety of conditions, but the process did not hold enough advantages to warrant its maintenance. However, great improvements in the recent art of air conditioning have opened the possibility that these may have put the problem on an entirely different basis. Consequently in 1927 an adsorption dry-blast plant using silica gel was installed at the Wishaw Works in Glasgow. The first modern refrigeration system developed by the Carrier Co. was installed in 1939 by the Woodward Iron Co. in Alabama. About a year later Blaw-Knox Co. erected a modern chemical absorption dry-blast plant for the American Rolling Mill Co.

Drying Methods — Gayley refrigerated the air by passing it over a battery of pipes carrying cold brine. After these pipes frosted up, the air was switched to another battery and the first was defrosted by warm water. The plants were expensive and cumbersome. Gayley stated that the moisture was kept below 1.75 grains per cu.ft., and was subsequently lowered to 1.4 grains. Blast at Hamilton was kept at about 0.85 grain; when the atmospheric moisture fell below this, water was sprayed in.

(Continued on page 552)

*Abstract of Bulletin 1078, Canadian National Research Laboratories, Ottawa, Canada.

re you worried about working stainless steel?



Have you ever wished that somehow, somewhere you could find all the answers about fabricating and welding stainless steel? Are you faced with the necessity of changing from one type to another—or of using a type you have never worked? Are you worried about differences in workability—and if changes may be required in your present methods?

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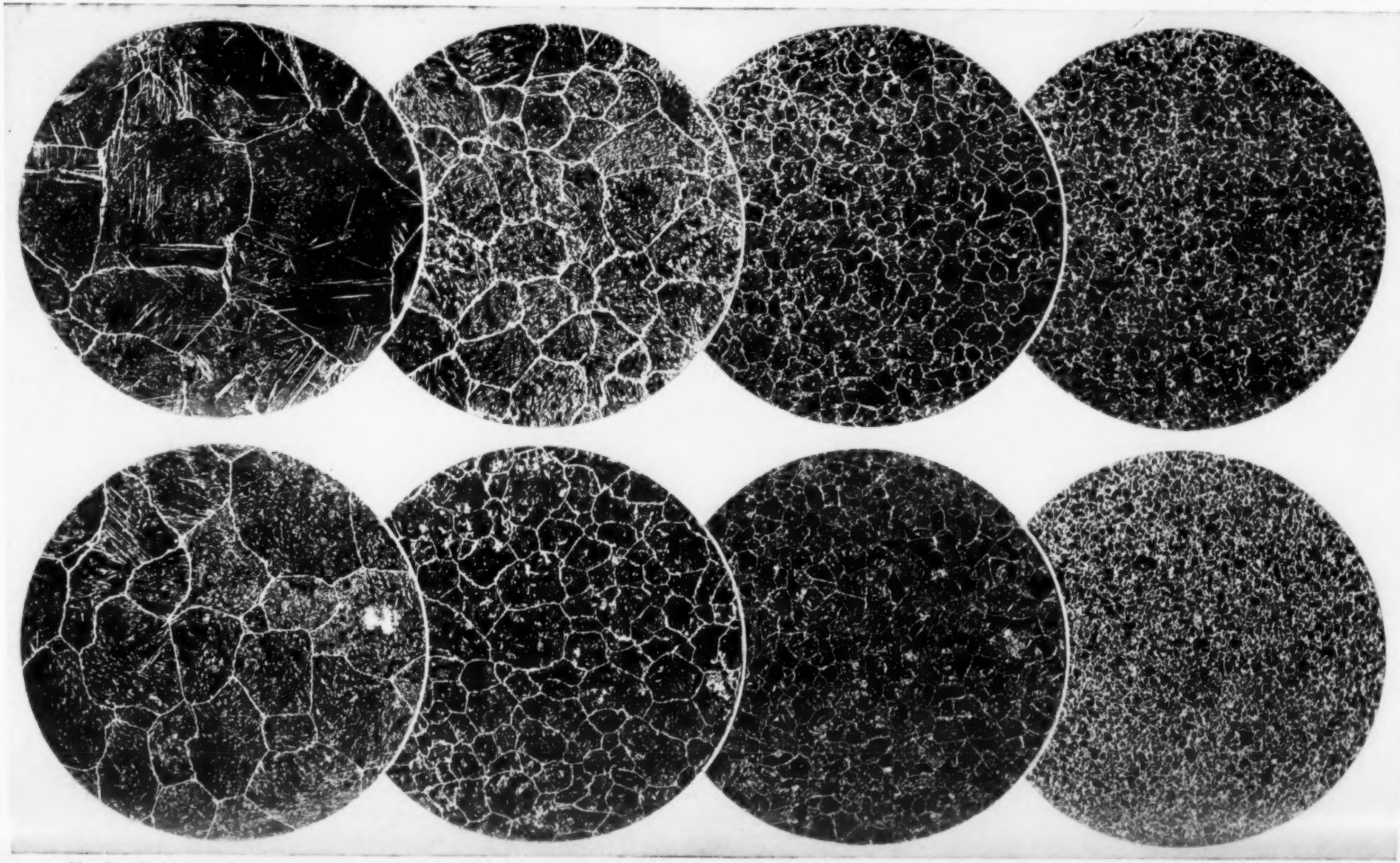
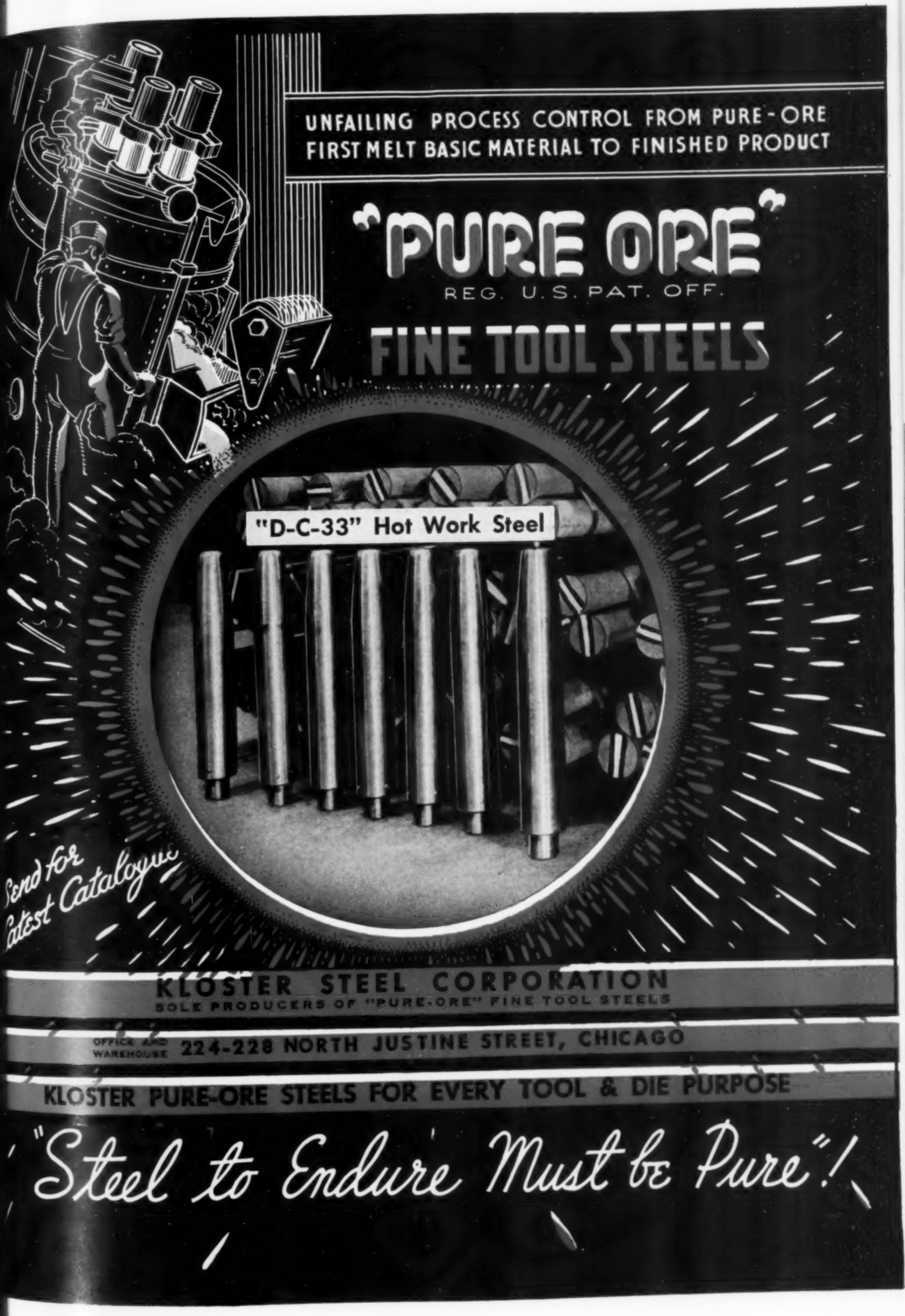
Grain Size No. 1; Up to 1½ per sq.in. — No. 3; 3 to 6 grains per sq.in. — No. 5; 12 to 24 grains per sq.in. — No. 7; 48 to 96 grains per sq.in.



No. 2; 1½ to 3 grains per sq.in. — No. 4; 6 to 12 grains per sq.in. — No. 6; 24 to 48 grains per sq.in. — No. 8; More than 96 grains per sq.in.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Dry Blast

(Continued from page 546)

Most recent installations, of both the refrigeration and chemical absorption types, have been designed to deliver air containing 3 grains per cu.ft. These systems can be used to produce drier air, but the plant and operation is then much more costly. Direct contact is achieved between air and refrigerant (or desiccator). For example, cold water is sprayed into the air to cool it to 40° F. Removal of spray droplets by means of eliminators produces a blast saturated at 40° F. but containing about 3 grains moisture per cu.ft. Engineering design provides units which are in marked contrast to the massive equipment of Gayley's day.

As far as is known, the Wishaw installation is the only one so far in which a solid adsorbent is used. The plant treats 35,000 cu.ft. per min. in six units, each consisting of a large steel box, containing trays of gel (in granular form). Air passes through five units while the other one is being activated, a process requiring about 1½ hr. Inlet air is filtered to remove dust. Moisture, over a period of 20 months, varied between 1.09 and 1.89, and averaged 1.37 grains per cu.ft.

Other solid adsorbents which could undoubtedly be used are activated alumina and active silica, the latter being a silica skeleton enormously porous, simply made from serpentine rock, capable of a high degree of sorption without feeling wet.

Theoretical Advantages — The literature contains much speculation about supposed advantages or disadvantages, and a little performance data. Since moisture in the air is already present as vapor, it represents so much dilution of the oxygen in the air and, to that extent, an additional load on the blowers. At the temperature of molten iron, water vapor reacts rapidly with coke, and as this reaction is strongly endothermic it is necessary to supply additional fuel to maintain the heat of the focus. On a humid summer day this may amount to as much as 10% of the total fuel, and of course increases the total volume of air compressed. There is also more coke ash to be smelted.

However, it is not all loss, for the hydrogen produced by the dissociation of H_2O is very active in reducing iron oxide in the upper part of the furnace. If recombination of hydrogen and oxygen into water vapor *does* take place, it generates heat in the shaft and tends to raise the smelting zone in the furnace, and this is objectionable.

J. E. Johnson, Jr. proposed

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Dry Blast

(Starts on page 546)

the idea that the useful work of a blast furnace is done only above a certain critical temperature, possibly 2750° F. That quantity of heat produced in excess of that required to heat the gases and solids up to the critical temperature is the only heat available for smelting. Removing the moisture from the blast saves the heat which would be necessary to decompose this moisture, and the excess or useful heat is raised to that extent. Calculations based on this theory indicate that up to 20% extra heat may be made available for smelting by drying the blast.

There is still another aspect: The CO content of the top gas is decreased, and the top temperature is lowered when the blast is dry. Thus Gayley reported a decrease of the $CO:CO_2$ ratio from 1.72 to 1.24. This, of course, reduces the value of the gas for heating and power purposes, and means that the dry blast must be judged on the economics of the steel plant as a whole. In other words, if coke is cheap and coal or producer gas is dear, the blast furnace may receive enough credit for a rich top gas from the fuel-using departments that it becomes a valuable gas producer.

These theoretical considerations seem to balance on the affirmative side, and one might assume that dry blast should be universal. Yet its use is rare. To solve this riddle a committee of the Franklin Institute, appointed in 1909 to investigate the effects of Gayley's system, reported that several advantages had been sustained by five years' operation:

1. Reduces coke consumption 15% and increases iron production 10%.

2. Keeps a furnace in more regular, uniform operation, and holds the zone of fusion more steadily near the tuyeres.

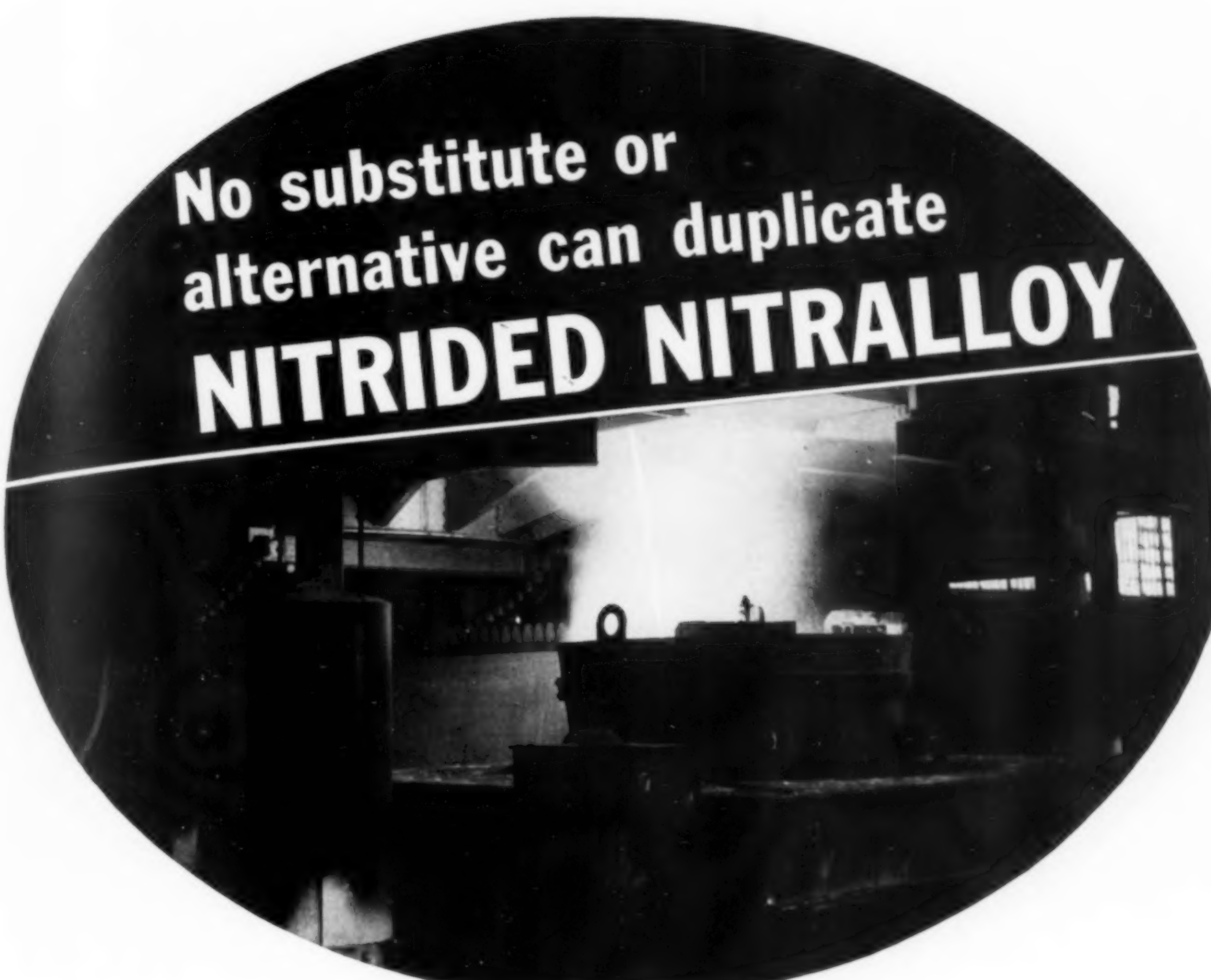
3. Prevents fluctuations up or down in the melting zone; therefore, hotter blast will cause no sticking in the furnace.

4. Lowers temperature of top gases and amount of flue dust.

5. Greater uniformity of metal, longer life of furnace lining, and saving in limestone.

The reasons for the failure of the earlier dry-blast installations doubtless center on the cumbersome and costly drying apparatus. This has been so changed that a reappraisal of the situation is in order. For example, Camp and Francis in the 1940 edition of Carnegie-Illinois Steel Corp.'s book, "The Making, Shaping and Treating of Steel", have expressed the conviction that there would be a definite field for dry blast when more economical methods for removing moisture were

(Continued on page 556)



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3011

Dry Blast

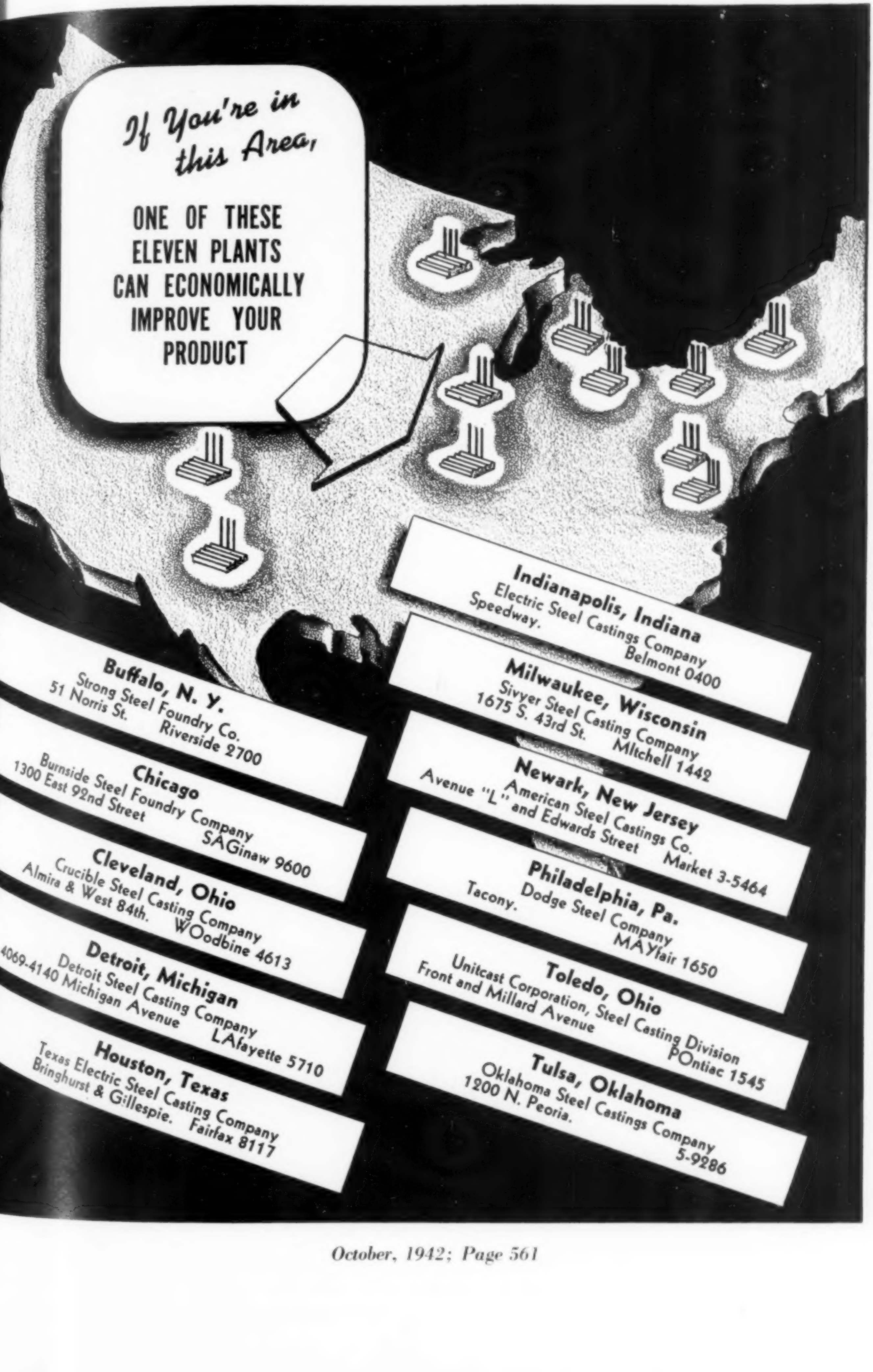
(Starts on page 546)

developed. In view of the number of recent installations we have now reached that stage.

While it has been shown that reduction of moisture to a uniform level eliminates thermal peaks, and hence permits operations with a much lower factor of safety, if a blast furnace superintendent insists on maintaining as high a fuel ratio as for normal air, he will fail to obtain the advantages realizable.

Various critics have maintained that dry blast can show improved and more economical operation only when applied to inefficient furnaces or furnaces smelting difficult ore. While it may be that benefits earlier obtainable from dry blast have been superseded by improvements in furnace design, if every advantage which can be derived from dry blast is provided for, *further* improvements ensue.

Conclusion. Published results of dry-blast operation indicate that removal of moisture from the furnace blast is a practical and economical means of increasing production and general efficiency. That winter operations of a non-equipped furnace do not always show more favorable results than in summer does not necessarily mean that dry blast of uniformly low moisture content cannot be beneficial. A more valid argument is that almost all the dry-blast plants erected early in the century were discontinued after several years' operation and what seemed to be a fair trial. However, these early plants were probably too high in first cost, difficult and costly to operate, and their replacement cost was too great. The improved design and lower cost of erection and operation of present-day dry-blast systems should warrant their application as a means of increasing blast furnace production and efficiency.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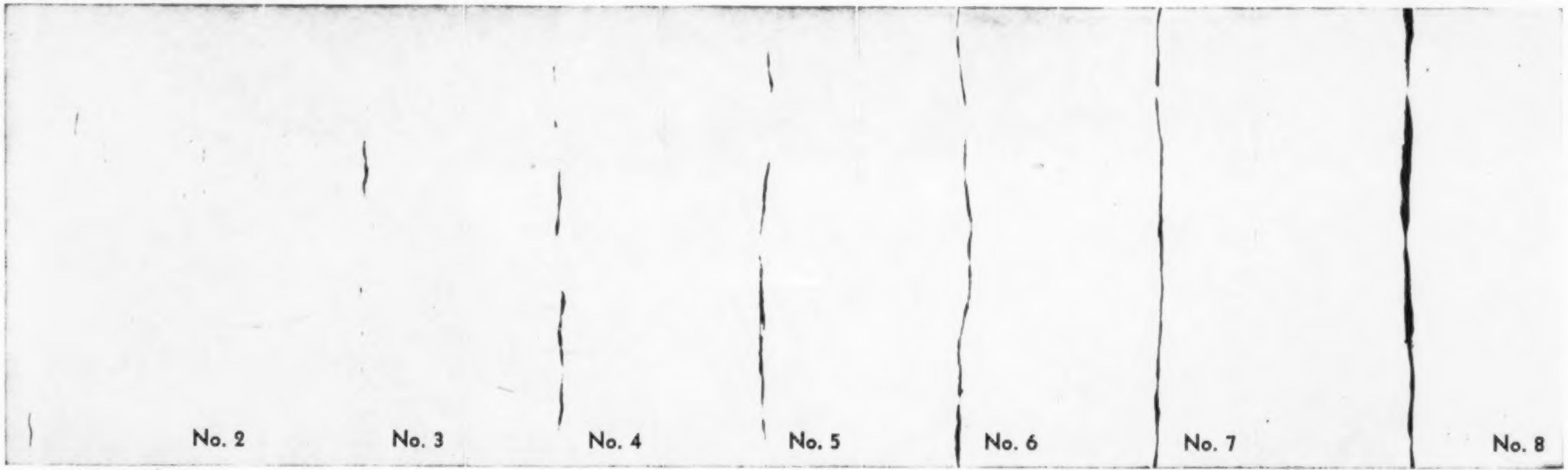
Rating of Inclusions ("Dirt Chart")

In use by Chevrolet Motor Co. *Developed by George W. Walker*

(General Motors Standards Book shows four types, A to D, of each variety as indicated in this style of type.)



G.M.↑A G.M.↑B Silicate Slag Inclusions G.M.↑C G.M.↑D, except that stringers are fragmented

←G.M. Type A shows scattered small inclusions→

G.M.↑B G.M.↑C Oxide Inclusions G.M.↑D

Huey Corrosion Test for 18-8 Steel*

By F. Meunier and H. M. Schnadt

ALLOYS of chromium, nickel and iron have remarkable resistance to corrosion. Widespread use of the variety known as 18-8 (approx. 18 to 20% chromium, 8 to 10% nickel) in chemical equipment has required that much of this alloy in sheet, plate and other forged or cast form, as well as welded joints therein, be proved by correct preliminary testing to make sure that the extensive apparatus to be made shall serve satisfactorily. One of the most widely used of these tests has been the one suggested by Hatfield (it is also known by the names of Monypenny or Strauss). It consists in exposing the weld to a boiling acid solution of $CuSO_4$, and then bending the specimen. The appearance of cracks at the joint indicates intercrystalline corrosion.

Americans seem to prefer the test proposed by W. R. Huey, wherein the specimens are subjected to corrosion for three periods of 48 hr. in not less than 500 cc. of boiling nitric acid, chemically pure and of 67% concentration — all in a reflux condenser. The samples are cleaned and weighed before and after each period. Acceptance usually requires that the total corrosion after the third period should not exceed 0.004 in. penetration per month, calculated from the sum of the losses in weight during each period.

The validity and sensitivity of any corrosion test are intimately related to the reproducibility of the results. In this respect the Huey test as applied to normal 18-8 steels has been approved simultaneously by 15 laboratories and recognized as furnishing "exact data which are quantitative and reproducible". This conclusion was reported to the American Society for Testing Materials in 1933. However, the severity of this test has raised the justifiable query whether it had any absolute significance, so that it would evaluate resistance to other kinds of corrosion than hot concentrated nitric acid, or at least to what degree it might satisfy this requirement of wide application.

For example, as first proposed and used (as an acceptance test for certain types of chemical

(Continued on page 568)

*Abstract of translation by George L. Schlaepfer for Welding Research Committee of the Engineering Foundation from Article in *Arcos* (Brussels, Belgium), Sept. 1939, p. 2161.

RMALLOY X-RAY *Inspection*

is on the ALERT too

Huey Test for 18-8

(Continued from page 564)

equipment) the test required five periods of 48 hr. each. For the judgment of welded joints the test has been frequently shortened to two periods with maximum corrosion rate of 0.004 in. per month, or to three periods with the same corrosion rate. In view of the fact that corrosion rates grow with succeeding test periods in a parabolic ratio, the three-period test means a considerable increase in severity. For example, if the coefficient of reproducibility reaches 30%, a maximum corrosion rate of 0.004 in. per month after three periods of 48 hr. each could not be assured unless the *average* of the tests was below 0.003. Now, welds of excellent quality, and found to be very resistant in service in a large variety of corrosive substances, have never produced corrosion rates below 0.005 in. per month, even when in the quenched condition. Thus we have here a requirement which is obviously excessive. Besides, the rate of 0.004 in. per month has previously been exceeded after only two test periods.

Some tests were made by the authors on weld metal of varying carbon content and heat treatments that confirmed in a striking manner the accuracy of the Huey test. Three 18-10 weldments containing normal manganese and silicon, and 0.25, 0.50 and 0.70% carbon respectively, were each cut into five specimens. All the specimens were quenched in water from 2100° F. to normalize their austenitic structure. One specimen of each type was kept in this condition while the four others were annealed during 1 hr. at 1110, 1290, 1470 and 1650° F. respectively, and then cooled in air. These 15 blocks were then examined microscopically, their electrolytic dissolution potential measured, and a Huey corrosion test made of three periods of 48 hr. each.

The mechanism of the precipitation of the carbides and of the resulting intercrystalline corrosion makes it possible to predict from the looks of the structure how the specimens ought to act under corrosive influences. The first samples, made homogeneous and austenitic by quenching, obviously would be the most corrosion resisting. The second group, annealed at 1110° F., is slightly weakened at the grain boundaries. The third group is greatly deprived of chromium at the boundary of the austenitic grains and will have great tendency to intercrystalline corrosion there, but nowhere else. On the other hand, the specimens annealed at 1470 and 1650° F.,

(Continued on page 574)

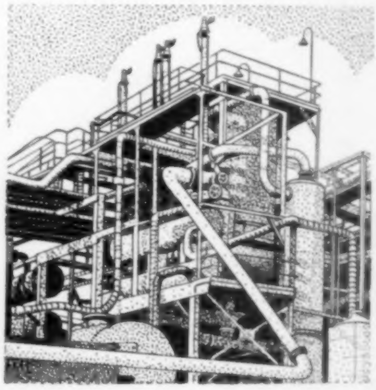
Huey Test for 18-8

(Continued from page 568)

where the more numerous carbide grains have been precipitated in an increasingly scattered large number, the diffusion of chromium is sufficiently rapid to prevent excessive exhaustion of chromium at the boundaries. The corrosion will be more distributed over the whole surface of the grain and might even be relatively less severe.

The measurements of electrolytic potential in normal H_2SO_4 against a 0.1-normal calomel electrode are known to be quite sensitive and indicative of corrosion rates when made under identical conditions. Results of the tests corroborate exactly the qualitative conclusions from the microscope. The greatest sensitiveness to corrosion corresponds to the temperatures around 1380° F., and to the steels of higher carbon content. Likewise, it is striking to see the remarkable agreement of the corrosion rates in boiling HNO_3 with the preceding methods of observation. The Huey test is thus a faithful translation of the degree of passivation or the heterogeneity of the metal. Its quantitative character and its relative simplicity are also very useful features.

Other corrosion tests were made by the authors on blocks of weld metal made under controlled conditions of analysis, deposition, and heat treatment. It was concluded that the rather high deviations of the individual 48-hr. corrosion rates from the expected amount (predicted from a parabolic increase of rate with time) was due to irregularities

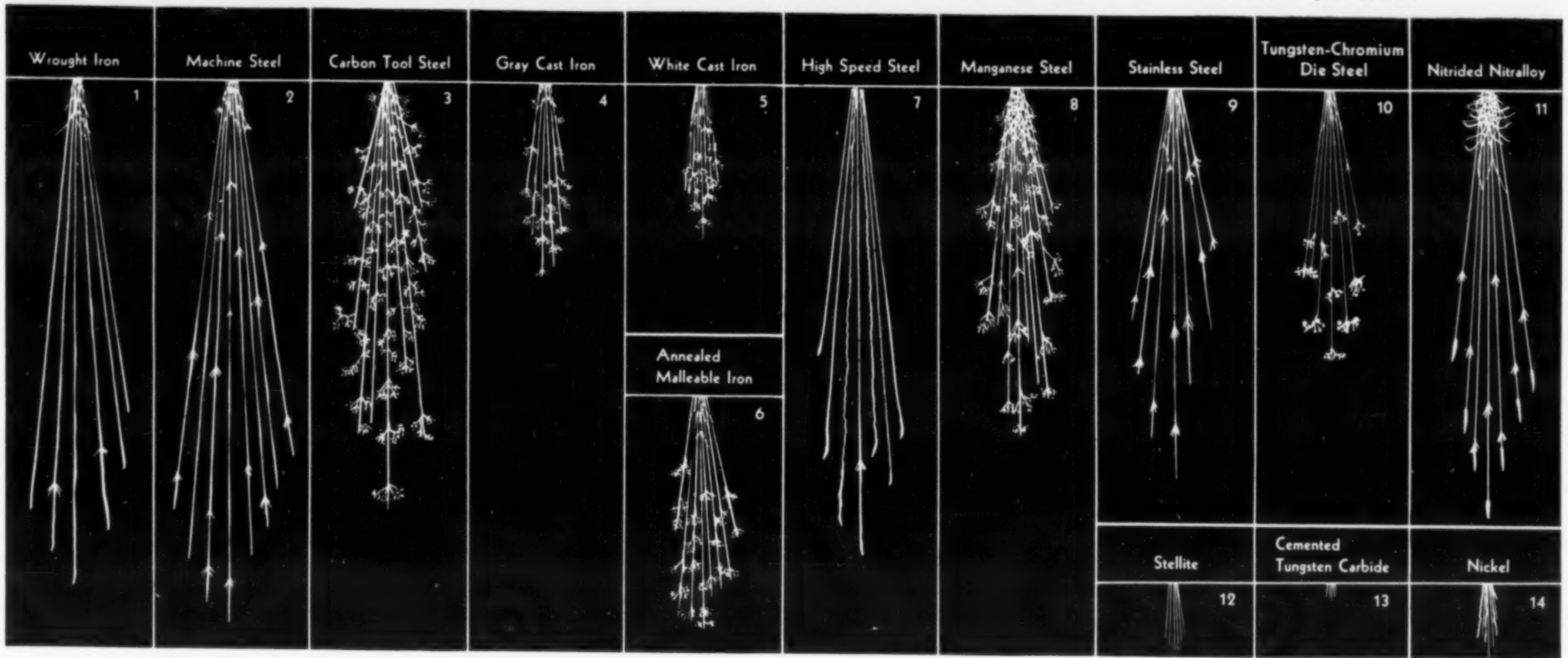


in the deposit. The tests likewise show that silicon in 18-8 alloy welds is not a corrosion inhibitor, in the sense of preventing "weld decay", a conclusion at variance with the general belief in France, but which agrees with American practices.

The general conclusion of these studies is that the Huey test, as applied to welded joints, is a very searching and accurate test, but that it is likely to be misapplied because many uses of welded stainless equipment do not require the excessively high quality that would be needed to pass the 0.004 in. per month limitation.

Spark Test for Metals

Reprinted from "Grits and Grinds" (Norton Co.), June 1940



Line	Metal	Volume of Stream	Length of Stream *(a)*	Color of Stream: Close to Wheel	Color of Stream: Near End	Quantity of Spurts *(b)*	Nature of Spurts *(b)*	Line
1	Wrought iron	Large	65 in.	Straw	White	Very few	Forked	1
2	Machine steel	Large	70	White	White	Few	Forked	2
3	Carbon toolsteel	Moderately large	55	White	White	Very many	Fine, repeating	3
4	Gray cast iron	Small	25	Red	Straw	Many	Fine, repeating	4
5	White cast iron	Very small	20	Red	Straw	Few	Fine, repeating	5
6	Annealed malleable iron	Moderate	30	Red	Straw	Many	Fine, repeating	6
7	High speed steel	Small	60	Red	Straw	Extremely few	Forked	7
8	Manganese steel	Moderately large	45	White	White	Many	Fine, repeating	8
9	Stainless steel	Moderate	50	Straw	White	Moderate	Forked	9
10	Tungsten-chromium die steel	Small	35	Red	Straw *(c)*	Many	Fine, repeating *(c)*	10
11	Nitrided nitralloy	Large (curved)	55	White	White	Moderate	Forked	11
12	Stellite	Very small	10	Orange	Orange	None		12
13	Cemented tungsten carbide	Extremely small	2	Light orange	Light orange	None		13
14	Nickel	Very small *(d)*	10	Orange	Orange	None		14
15	Copper, brass, aluminum	None				None		15

(a) Figures obtained with 12-in. wheel on bench stand, and are relative only. Actual length in each instance will vary with grinding wheel and pressure.

(b) "Spurts" are the sparks (seemingly small explosions) that occur at intervals on the carrier lines.

(c) Spurts are blue-white.

(d) Some wavy streaks may be observed.

Furnaces and Heat Treatment

Blast Furnaces Break Records

BLAST FURNACES have produced an unusual amount of pig iron, not so much because of *recent* changes in design as because of more intensive use of existing equipment.

The fact of the matter is that, before the war program was started, we had perfected blast furnace and openhearth designs to such a degree that further serious effort to improve designs was definitely of less importance than the putting forth of every possible effort to increase the rate of building new capacity and providing auxiliary facilities for making more steel.

The designs as crystallized before the real start of our war preparation campaign were such as to make possible the record breaking production of one blast furnace which averaged 1348 tons during January; another averaged 1403 tons during March and another furnace again broke the world's record by producing an average of 1415 tons per day during the month of May of this year. We are proud of the fact that all these record breaking furnaces were built or rebuilt by Arthur G. McKee & Co.

We are building other very large furnaces and the fact of the matter is that all of the large blast furnaces recently built and building, rated at 1200 net tons per day, should be able to produce an average of 1500 tons per day if the management and crews of these furnaces put as much effort into the blowing of them as they would if the Germans and Japs were actually shooting at them instead of at their sons, brothers and friends.

Under these circumstances our best contribution to the war program was — and is — first, the using of our total influence with the industry to the end that present equipment be blown just as hard as possible, which should materially increase the tonnage above the present rate and, second, to design and complete the construction of more and more blast furnaces and openhearth furnaces in the shortest possible time.

After the first declaration of war in Europe in September, 1939 and up to the present time, 10 new large blast furnaces have been built and 10 existing blast furnaces have been rebuilt to large size. These new and rebuilt blast furnaces should increase the production, as against September, 1939 by 6,417,000 short tons (a figure which includes one large Canadian furnace).

As of mid-August, 1942, 24 additional furnaces are under construction or re-construction (15 new, 2 being moved and 7 being rebuilt) and these should add to the annual capacity of this country some 7,624,000 short tons — 2 blast furnaces being built in Canada which will add to the Canadian output approximately 770,000 short tons.

In other words, up to the present time, since the declaration of war in Europe, the annual capacity of the United States has already been increased 6,106,000 tons by the construction of new furnaces, and by the rebuilding and relining of old furnaces, and by the end of 1943 all of the blast furnaces now under construction should be completed and the total increase of pig iron capacity since war was first declared should be 13,730,000 tons. The rated capacity in the United States should then be 71,340,000 net tons of pig iron annually.

It will be noted that this is by far the greatest addition ever made to our pig iron producing capacity in an equivalent time.

ARTHUR G. MCKEE
President
Arthur G. McKee & Co.

Electric Furnaces for Electric Steel

AMERICAN Bridge Co. (a subsidiary of U. S. Steel Corp. and pioneer in the building of arc melting furnaces in the United States) has been constructing Heroult furnaces for the past 30 years, and at present has standard designs ranging from 1½ to 100 tons rated capacity. During the last four years it has been instrumental in building and putting in service approximately 80% of the new electric furnace ingot capacity in the United States, together with a large number of units for foundry use.

At present the company is working full time in getting out furnaces of 50, 60 and 70-ton nominal rating for the production of alloy ingot steels used in the war effort. Planes, ships, tanks and guns could not be built to the high standards required by our Government without electric furnace steels, and American Bridge Co. is proud of its contribution to this important part of the war effort.

AMERICAN BRIDGE CO.

Openhearth Records
due to managerial ability

AN INCREASE of steel production is mostly dependent on the installation of new ingot producing facilities and is only subordinately concerned with improvement in the design of steel making furnaces which, contrary to a generally held opinion, have been developed to a high technological plane. Rather, an increase of steel production is more intimately concerned with the caliber of the administrative and supervisory personnel's ability to fulfill and coordinate the vital supporting services, such as procurement of raw materials, scheduling of charge to furnace, and ingots from the furnace through the blooming mill.

Current production rates are only being maintained because of the American steelmaker's ingenuity in converting almost any ferrous material into good steel, and to the willingness of all concerned to make and continue the almost superhuman efforts which are achieving the present monumental but necessary results.

A brief restatement of our productive position may be in order:

The outbreak of World War II found the American steel industry with an ingot capacity of about 81,600,000 net tons (December 31, 1939) made up of openhearth capacity, 73,700,000; bessemer steel, 6,000,000; and electric furnace steel, 1,900,000.

During 1940 and 1941, as a result of the darkening clouds, capacity was increased by almost 7,000,000 tons and the production averaged nearly 90% of capacity during the period.

Pearl Harbor found us with about 88,500,000 tons of ingot steel capacity made up of openhearth, 78,100,000; bessemer, 6,700,000 and electric furnace, 3,700,000. Since that time the industry has produced at the rate of nearly 97% of capacity.

Under the existing schedules of W.P.B., outlined by W. A. HAUCK in METAL PROGRESS for August, it is proposed that by the middle of 1943, the American ingot capacity will be about 98,300,000 net tons, consisting of 85,800,000 tons openhearth; 6,700,000 tons bessemer; and 5,800,000 tons electric furnace capacity. Production at this rate will likely be difficult to approach on account of the ore and scrap situation.

WILLIAM C. BUELL, JR.
Consulting Engineer
Arthur G. McKee & Co.

"Custom Built" Furnaces Made on Production Line

CONVERSION of the Nation's metal manufacturing industries almost completely to wartime purposes, and a rapid expansion of its many branches, has naturally caused many rapid changes in activities of Ajax Metal Co. and its four divisions specializing in furnaces and heating methods. Even in the more specialized activities of the parent company (the production of non-ferrous ingot metals for foundries) technical advances are disclosed in the form of new silicon bronzes and high-tensile manganese bronzes, for broadened utility and conservation of strategic metals.

The advantageous use of the Ajax-Tama-Wyatt aluminum melting furnace has within the year been firmly established — nearly 100 are now in use. Due to the fact that the Ajax-Wyatt low frequency induction furnaces are

"standard" in the wrought brass industry, when the abrupt demand for 500,000 tons of new melting capacity arose, they were naturally the ones to be chosen. Mass output of these furnaces, formerly "custom made", was successfully accomplished in the best tradition of American engineering and pioneering skill in meeting new conditions.

In the high frequency melting and heating field, Ajax-Northrup furnaces were devised in multiple batteries for centrifugal gun castings, melting high alloy steels, and heating for hot-forming on a host of ordnance assignments. These will revert, as planned, to peacetime use during a later, happier day.

Industry's use of the immersed electrode salt bath heat treating furnace (Ajax-Hultgren) reached and passed the impressive mark of 1000 installations, with new applications explored, proved, and geared into production lines within an astonishingly brief period of time. In this work, our staff engineers worked closely with the best metallurgical and production men in developing furnaces for unusual, yet logical, applications — as for example, carburizing up to 1/8 in. case depth, shot hardening, and for mouth and taper annealing of steel cartridge cases.

With the widest possible exchange and pooling of knowledge and experience, technological advances are bound to be spectacular during this period. It is a matter of pride with us all to report that we are keeping the pace, for that is no more than keeping the faith in the most intense metal-working and fabricating effort ever put forth.

G. H. Clamer
President & General Manager
The Ajax Companies

More Electric Furnaces Make More Quality Steel

We are operating 24 hours daily, seven days per week, building electric furnaces in increasing numbers to meet the insistent demand that "there must be more steel". Electric furnaces are considered next to front line war machines, such as tanks, guns, airplanes and ships, and with the full realization that the equipment to make this war must be produced in increasing quantities and the operating efficiency increased, we have greatly increased our productive and engineering forces and are pushing the shop every hour around the clock. How urgent this matter is may be judged from W. A. Hauck's statement from the War Production Board, quoted in the August issue of Metal Progress, that electric furnace capacity, already at an all-time high of 3,741,310 net tons of steel ingots on Jan. 1, 1942, must be further increased by July 1, 1944, to the grand total of 5,759,310 tons.

There are also other ways of increasing the tonnage of an electric steel department beyond building other furnaces, and we are proud that the top charge feature of our equipment (highly advantageous for increasing production and lowering the operating costs) has been improved in many details so as to permit more rapid charging of the furnace and less time between heats. This also results in less power, electrodes and refractories.

With the change in scrap conditions where light, fluffy scrap — the so-called "hay" — must be used, the volumetric capacity of all of the Lectromelt furnaces has been increased by making the furnace higher. A larger charge of this light weight scrap may thus be placed in the furnace. By this and other means, all of the 600-odd Lectromelt furnaces in operation are being pushed to the limit.

H. H. Watson
Pittsburgh Lectromelt Furnace Corp.

Melting Furnaces right up at the Front

The production stimulus attendant to the war effort is taxing the capacity of the electric furnace manufacturer to the utmost. Like other furnace makers, we are operating our plant three 8-hr. shifts a day in an effort to make deliveries within a reasonable period, yet an unprecedented backlog now extends well into 1944. This does not mean that deliveries on new orders cannot be made until 1944, but rather that the electric furnace production is synchronized with major construction work such as the shipbuilding and synthetic rubber program. It is possible to fulfill other and newer contracts in the meantime with deliveries of from two to six

months, depending upon furnace size, specifications and urgency.

Improvements in construction, simplified design, and developments in melting technique have greatly expanded the economical application of the indirect arc furnace. It is now provided with completely automatic features for the rocking cycle and control of power input, so that its operation is virtually automatic, except for charging and pouring — an important matter, in view of the shortage of skilled melters.

Many of the new installations are provided with interchangeable shells so that one may be used for ferrous alloys while the other is reserved for non-ferrous, thus greatly enhancing the versatility of the installation. This is especially important in outlying installations, frequently remote from centers of industry.

Newer installations include furnaces for the tonnage production of aluminum bronze, beryllium copper, Navy "M" and Navy "G" bronzes, cupro-nickel and Monel metal, in addition to many other brasses, bronzes, and special alloys. The ferrous installations include the melting of gray and white irons both plain and alloyed, and carbon and alloy steels. The products made are predominantly for the Army and the Navy, either for ordnance materiel and equipment or for maintenance and repair, wherever ferrous or non-ferrous castings are required in the field.

ALBERT E. RHOADS
Manager
Detroit Electric Furnace Division
Kuhlman Electric Co.

Six Times as Much Insulating Brick

HOW WELL we meet the stupendous increase in demand for industrial materials for war production may well prove to be the acid test for our traditional system of free enterprise. All indications to date suggest that the final results will meet our expectations. When the final score is totalled, I feel sure that the refractories industry will be high among those which helped to maintain our way of life.

A single unit in this great national effort, Johns-Manville is today shipping to vital industries about six times the number of insulating and insulating-refractory brick that it supplied at the beginning of the war in Europe, just three years ago. Part of this increase has been achieved through the more complete use of our existing facilities for production, the re-enlisting of obsolete units which were still usable, and the addition of equipment. The balance of the increase came from a new plant in Pennsylvania, which was rushed to completion, well ahead of schedule, early last year to meet the needs of defense plants then springing up throughout the country. Since the new plant went into operation its capacity has been doubled — and every effort is being made to continue to boost production here and at our two other brick plants without adding to the demand for critical materials.

This story about insulating brick, however, is only a single phase of the broad picture. Most of Johns-Manville's 1200 products are now being used for the war effort, and the percentage is being increased daily as more ways to help are worked out. In addition, at the request of the Government, the company undertook last year the assignment to build and operate a huge ordnance plant in the Middle West.

The attitude of the company is expressed, I believe, in a statement of LEWIS H. BROWN, president, before a conference of representatives from the company's factories and mines:

"We're 100% out to win this war . . . if it takes all of our profits, all of our personal incomes, privileges and comforts, all of our waking moments of effort and thought, and even our lives. There is no other choice. We can and will adjust ourselves and our operations to every new condition we may be called upon to face — save one. And that is learning to say 'Heil Hitler' because of a defeat by the Axis powers."

G. E. GRIMSHAW
Manager, Industrial Insulation Dept.
Johns-Manville Sales Corp.

Helping New Men Perform New Tasks

THE PRESENT EMERGENCY has placed unprecedented demands on the heat treating industry, coming from metal working shops in all regions, for practical metallurgical advice on products and methods to expedite the production of ordnance. Many such plants are manu-

facturing and heat treating armor piercing shot, fuselage parts, armor plate and machine guns, which had never before required the services of metallurgists or heat treaters, because their previous production had not employed furnace equipment or metallurgical skill. Field metallurgical engineers from Park Chemical Co. have endeavored to assist such concerns in starting up and operating new types of salt baths, because of the utter impossibility of securing experienced metallurgists.

We have also introduced several new metallurgical products, to serve industry more effectively, including *(a)* an all-coke base type of solid carburizer (non-burning), capable of producing the proper types of "case" and carbon content in molybdenum steels; *(b)* a pre-mixed coating for selective carburizing known as "No-Carb", which can be applied to all types of steels by brushing, dipping, or spraying, to prevent carburization, and is also exceptionally effective on molybdenum steels for the prevention of decarburization during rolling and forging operations; *(c)* "No-Scale", another liquid, which is used in a similar manner as a die lubricant for alloy forging steels, for prevention of excessive scale during such operations. Both of these coatings conserve valuable alloys from loss due to oxidation.

New types of neutral salt baths have working ranges which make production hardening, brazing, annealing, nosing, and forging operations all possible in liquid salts, without scaling or decarburization. Neutral salt baths are now producing many thousand armor piercing shot daily, which meet all ballistic tests.

After these new materials are installed in new plants and operating properly, our job is not done. Our continuing job is to *keep* them operating efficiently.

Harrison I. Dixon
Vice-President
Park Chemical Co.

Consumers and Producers Study Problems Cooperatively

SUCCESS of the metal industry in meeting and exceeding the quotas set for it in war production has been due in no small part to its many suppliers of processing materials. These suppliers, by development work and adaptation of existing products to new processes, have been able to provide heat treating and metal working procedures which conserve vital materials and speed up former methods.

For example, take the heat treatment of high explosive shells. The steels first used did not require an oil quench for proper hardening. When alloy steels were replaced by such common grades as S.A.E. 1345, oil having a fast rate of quenching was found necessary, and both the oil and the quenching mechanism had to be devised to fit that need.

For carburizing light armor plate, we have been able to perfect a compound which has materially reduced carburizing time, thus increasing production and at the same time conserving charcoal.

In the machining of gun barrels it was soon found that the choice of cutting oil made a great difference in both quantity and quality of production. Oils had to be developed which would permit rapid, accurate manufacturing in the faster machines now available for deep-hole drilling and rifling.

When cartridge cases of steel were first suggested to replace scarce brass, the work required a drawing compound which would extend die life and assure perfect cases. Houghton's staff worked closely on this problem with concerns having experimental contracts and the successful solution had much to do with the transition to mass production. For annealing after the tapering operation, a salt bath has been found satisfactory for selective treatment.

Therefore it has not been a problem of merely stepping up production in the supplier's plant. War production has required, first, determining the requirements; second, adapting either new or old products to those needs after experimentation in the field; and last, getting our own plants into mass production on the products which field work had ascertained as necessary. As the munitions program unfolds, and changes in metals continue, all three stages are still required; it is first and foremost a problem of cooperative work in the field, and there is no more cooperative industry than metal working — hence our national success.

George W. Pressell
Executive Vice-President
E. F. Houghton & Co.

Producing More Furnaces— better and faster

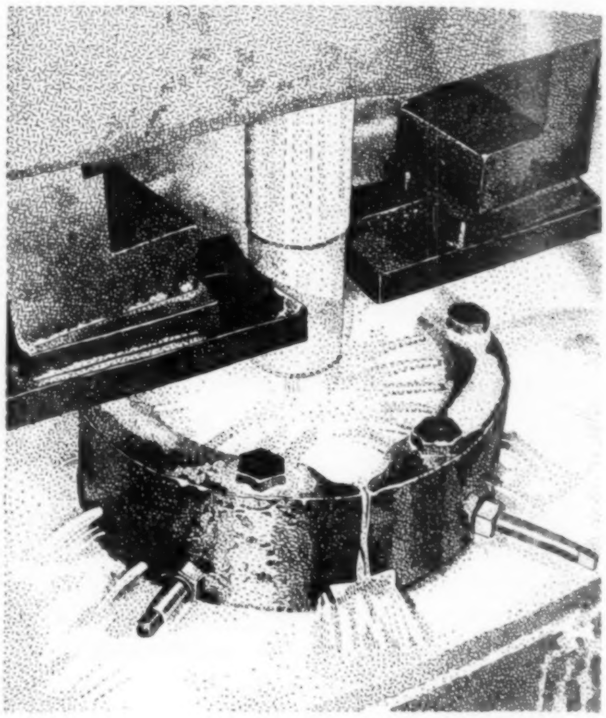
UNPRECEDENTED demand for war materials, plus the fact that accurate heat treatment is required for innumerable metal parts and products entering into this essential equipment, has placed a tremendous burden on the heat treating facilities of practically every metal working plant in the country. Not only is it necessary that tanks, aircraft, munitions, ships, guns, be produced in the greatest volume in history, but it is also necessary that this equipment meet more exacting specifications so it can stand up under the more severe conditions encountered in modern warfare, and do so with a minimum consumption of man-hours — often not too skilled.

Electric Furnace Co., along with the entire furnace building industry, is playing an important part in these tremendous days by devoting its entire efforts to designing and building production furnaces as well as time-saving and labor-saving auxiliary equipment for handling the work as it goes through. Thus we are producing the common aim: More essential war products — better and faster.

This company has already increased its production nearly six times its normal capacity. This has been accomplished by working additional shifts, by greatly expanding its structural and machine shops, by increasing its engineering department, by the installation of labor-saving equipment, by subletting part of its heavy casting and structural work, and by the addition to its plant personnel.

All of the electric and fuel fired furnace equipment it is manufacturing (and it runs mostly to large-capacity units) is being utilized for the heat treatment of essential war products such as shell forgings, tank armor, cartridge cases, bomb and gun parts, machine gun cartridge clips, aircraft and aircraft engine parts, aluminum and magnesium castings, wire and wire products, tubing, bolts, springs — the list could be extended almost indefinitely to many other metallic materials entering into the construction of war products.

R. F. Benzinger
President
Electric Furnace Co.



More Furnaces in 18 Months Than in 15 Years

TIMES such as these bring full realization of the importance of planned development during previous, more normal periods. Without such a widespread program of research and development, the industrial furnace industry never would have been able to meet the unusual demands made upon it today.

The furnace industry has always been faced with expediencies. New materials — new methods — new products — found their first bottleneck in production in the heat treating stage. Once the principles of processing these were established, it made little difference what ultimate form they took.

As a result of all this, the furnace industry had but to adapt the peacetime furnaces to the needs of war. This, while a simple statement, is not altogether a simple task. At Surface Combustion alone, more orders have been booked in the last 18 months than in the previous 15 years! Such a tremendous production task had to be accomplished with practically the same supervising personnel, for the "know how" of furnace production cannot be set up on a mass basis.

Years of experience are necessary to handle adequately the many problems attending each special furnace built. But the record shows what was done and how the furnace industry has expanded its productive capacity to meet the country's emergency. Surface Combustion, for example, has increased its production some 400%, in spite of the fact that we have always been by far the largest producers of heat treating furnaces.

"Right . . . and on time" is not just a slogan on the traveling crane at Surface Combustion where it has been displayed for years. It is a living principle, with years of performance to back it up. It moved us years ago to anticipate greater need for heat treating equipment with four important measures:

1. Production operations were simplified wherever possible.

2. Departments and equipment were rearranged to bring related operations closer together.

3. An improved production control system was instituted to keep things rolling on predetermined schedules.

4. Subcontractors used to fullest extent.

Yet this is only the beginning. New adaptations of peacetime results to wartime needs are being found every day. Each day, too, finds refined methods of planning and production going into effect. These, together with untiring effort, singleness of purpose and good salty American sweat, will put America's industrial furnace problem over the top.

HENRY M. HEYN
In Charge Heat Treat Division
Sales Manager
Surface Combustion

Convection Heating Extends to High Temperature

THE PAST FIVE YEARS have seen the complete development of annealing (low temperature heating) by the principle of high velocity convection wherever accurate uniformity has been required. No controversy now exists regarding the desirability of this method.

During the past 12 months the armament industry has been getting the advantages of this revolution in heating methods, extending to temperatures as high as 1700° F. The lag in the use of convection heating for such high temperatures has been due first to the mechanical problems of operating fans at heat, and secondly to the general belief in the industry that convection heating was impractical at radiant temperatures. While considerable work had been done with high temperature fans in carburizing furnaces, the theory understood and advanced by the manufacturers was that such circulation was for the diffusion of the gases for uniform chemical results rather than primarily for the advantages in heating. Furthermore, the furnaces were all of the radiant type where the heating source was in the same chamber as the charge or retort.

Amazing results from a standpoint of production per unit of hearth area, in the elimination of distortion, and simplicity of operation have indicated to us that 100% convection heating at high temperatures will follow along the same path that 100% convection heating at moderately low temperatures has followed.

CARY H. STEVENSON
Vice-President
Lindberg Engineering Co.

Furnaces Designed to Save Critical Materials

INDUSTRIAL FURNACE and auxiliary equipment manufacturers have contributed to the war effort by their wholehearted cooperation with the demand for more armament and speed in delivery. The effectiveness of their work is particularly noteworthy when we consider the problems confronting the furnace manufacturer, principally the restrictions in the use of critical materials. By ingenious engineering design, substitute alloys and refractories have been employed, and they operate satisfactorily as furnace parts without affecting the efficiency of the furnace or seriously reducing its required life.

We, as manufacturers of heat processing equipment, are conscious of the fact that certain materials must be diverted to uses where they are indispensable. Simplification of furnace design is possible, and can save critical materials if backed up by sound engineering gained by experience. In numerous instances we can prove that a simplified design has reduced the cost of the original installation, cut operating

and maintenance expense, and still turned out a product which in every way met the most critical specifications.

Where it is necessary to produce parts with critical surface requirements directly after heat treating, we have the automatic controlling devices and atmosphere generators to do the job. However, where the actual requirements are less critical we have developed and should use simplified designs making use of more available materials and equipment to the end that planes, tanks, ordnance and ships may be produced in sufficient quantities and "on time".

A. J. NORDENSON
Sales Engineer
Mahr Mfg. Co.

Furnaces Become In-Line Production Machines

JUST A GENERATION AGO our country was faced with problems similar to those before us now, but with what a difference in our ability to turn out the tools of war! If we want to understand how our present capacity has come about, we must compare item for item in the production line and give recognition to the part played by better management, better metals, better tools, more highly developed systems of mechanical handling, and above all, the tremendous changes which have taken place in the heart of the production line — the gas furnace.

The furnace has been revolutionized. Where it once was a batch machine in a separate dark and smoky building, with in-and-out handling requiring much backtracking and additional steps, it is now a continuous automatic heat treating machine in the production line. Where it once had to be followed by pickling, grinding and polishing, these steps can now be omitted by the use of controlled gas atmospheres which produce or maintain exactly the surfaces which are wanted without further treatment.

Special gas atmospheres originally were applied for protecting sheet steel during annealing — a rather simple operation at moderate temperatures — but research and development in the metallurgical field soon showed their advantages for all kinds of surface treatment. Bright annealing, bright hardening, direct gas carburizing, and many other new processes were based upon special gas atmospheres. The full significance of these developments in speeding production and in improving quality has never been realized as much as today when we are faced with the job of turning out the vast volume of war materiel which the United Nations will need to bring the war to a victorious conclusion.

By the end of 1942 the shift from consumer goods to war production will be practically complete. This accelerated change has required the greatest ingenuity in adapting existing equipment for unexpected uses. In addition, many new applications of gas have been made about which there will be many stories once the censorship permits. A single illustration must suffice; it is the automatic heat treatment of high explosive shells carried out in controlled atmospheres in a single continuous automatic unit which hardens, quenches and draws without intervening handling, and without subsequent cleaning.

A glimpse of the effect of war production is revealed by the rapid growth of industrial gas sales during the first six months of 1942. They have continued to increase and are currently running 12% ahead of the tremendous volume used in the preceding period.

GEORGE F. B. OWENS
Chairman, Industrial and Commercial Gas Section
American Gas Association
(Asst. Vice-President, The Brooklyn Union Gas Co.)

Modern Gun and Armor Furnaces

LIKE ALL OTHER industrial furnace manufacturers, our company has found that the demands of munitions' manufacturers have caused its business to assume a tremendously diversified nature as compared to the former line of manufacture — in our case principally bell-type annealing furnaces with controlled atmospheres. While a great many of these have been adapted to production of war materials such as bullet core coils, rifle clip and cartridge clip strip stock annealing, and more recently for the spheroidizing of steel plate for the production of steel shell cases, we have turned our energies to producing other equipment which fits itself into the specialized needs of armament.

Two basic contributions have been made by the Lee Wilson Engineering Co. in the nature of new and original developments for speeding up production of essential materials for the armored services. The first was in the production of armor plate in the design of an annealing furnace for charges up to 500 tons, handling about five times the tonnage of furnaces of more conventional design occupying the same floor space.

The second development referred to has been the production of continuous heat treating plants where the large caliber gun tubes are hung vertically and conveyed through continuous normalizing, hardening and quenching, and tempering furnaces, all without interruption. The result of this type of heat treatment has been the production of three to four times the number of guns that could be treated in the same plant space by older methods.

J. L. Whitten
Sales Manager
Lee Wilson Engineering Co.

Electric Furnaces, 16 to 1

A 16-FOLD INCREASE in orders for electric furnaces during the first six months of 1942 over a like period in 1937, one of the best pre-war years, is a measure of the war's demand on the electric furnace industry. Partly by plant extension, but principally by working around the clock and by sub-contracting, the industry has met the requirements in a manner that is a real tribute to all of its members.

The industry was prepared also, because of its intensive developmental activities during the past few years, to provide furnaces to meet the great variety of precision heat treatment required by our modern war plants. Many of these furnaces are fully mechanized for automatically conveying parts through the various heating and cooling cycles, and are provided with a protective atmosphere that maintains the original surface condition on the parts. Many are heated by forced convection of air or furnace atmospheres, thus insuring rapid and uniform heating.

Modern furnaces represent quite a contrast to the furnaces available in World War I, when batch heating without atmospheric protection or forced convection was the accepted standard. Conditions then, as remembered, seem crude indeed. Furnace copper brazing had just been discovered in the laboratory and was not attempted in production until many years later. Now it is a major production tool, contributing greatly to our manufacture of war machines.

Carl L. Ipsen
Manager, Industrial Heating Section
General Electric Co.

Bright Hardening Atmosphere readily produced from commercial gas

BRIGHT HARDENING of the alloy and carbon steels without oxidation (scale) or decarburization (soft skin) is an art fortunately developed in time to aid mightily in increasing the production of products for our armed forces. In a wide variety of applications in the aircraft, munitions and metal processing industries this modern method of hardening has saved countless man-hours of labor and a considerable volume of material because:

1. Products are uniformly heat treated under controlled conditions.

2. Number of machining operations are reduced, both before and after heat treatment, because the product is absolutely clean after heat treatment and tolerances and allowances can be scheduled accordingly.

3. In many instances expensive and time consuming grinding operations are entirely eliminated, since product is not decarburized and no soft skin exists to necessitate such operations.

4. Expensive cleaning operations are also eliminated, since the product, correctly hardened, is clean and free from surface oxidation.

5. Such atmospheres are applicable to modern continuous hardening heat treating equipment, which allows close control of quality and assures uniformity of product with a minimum of labor.

Our outstanding contribution to this general situation has been the successful application of a recently developed prepared atmosphere called "Endogas". It is produced from a completely reacted mixture of any commercially available fuel gas with air under controlled conditions of temperature such that a dry gas containing no carbon dioxide and a high combined percentage of hydrogen and carbon monoxide is obtained. These results awaited the develop-

ment of automatic equipment for controlling the "carbon pressure", a Westinghouse device which is easily set to produce a gas atmosphere in equilibrium with any steel desired, and this gas analysis is thereafter maintained automatically.

C. E. Peck
Heating Engineer
Westinghouse Electric & Mfg. Co.

Bright Hardening of Ordnance Parts

AMERICAN INDUSTRY'S response to the President's call for unprecedented production of war products is, in the final analysis, the sum of the developments of the many progressive companies and engineers who compose American Industry. Our company is but a relatively small part of a magnificent whole, but we are proud of our contribution, particularly in the field of protective gas atmospheres in heat treating furnaces. We are now able to turn over, to production of ordnance parts, a complete art which started its development several years ago.

In 1935 Holcroft's first charcoal gas generator was installed with a continuous heat treating furnace for hardening automotive transmission gears. Bright annealing had been done for some time; bright hardening from considerably higher temperatures was an entirely different proposition. Fortunately, charcoal gas was destined to revolutionize clean hardening, gas carburizing and carbo-nitriding, principally because it was free from the decarburizing agents, CO_2 and H_2O, omnipresent in commercial atmospheres provided before that time. Attempts to neutralize their effect by adding hydrocarbons gave unsatisfactory results.

In practice it was found that charcoal gas added directly to a furnace will not decarburize even a high carbon steel being treated. A relatively very small addition of hydrocarbon gives the gas active carburizing properties, and its activity may be controlled by one valve only — the valve controlling the hydrocarbon addition. Clean work, uniform carburizing, ease of control, freedom from soot, and relatively long alloy life were achieved in one stroke. In the same manner, small additions of air or of cracked gas make it neutral to medium and low carbon steels. Change from one atmosphere to another is rapid and results are sure. Manufacturers of airplane engine motors, tank and gun parts have welcomed this control and flexibility.

A tremendous amount of work has devolved upon furnace manufacturers, in adapting existing furnaces to ordnance parts, and in building new furnaces for specialized operations. In all this work, the successful treatment without scale or tarnish has saved innumerable cleaning operations and expense.

Improvements in gas preparation units have naturally followed extensive use and experience with the earlier designs. A new type of generator producing a gas having the same desirable properties, without the inconvenience of handling charcoal, has recently been developed. Carbon from gas deposited in the generator, together with the carbon of the gas itself, performs the function of the charcoal. May we compliment Westinghouse Electric & Mfg. Co. for leading the way in this latest development.

J. A. Dow
Chief Metallurgist
Holcroft & Co.

Truly Automatic Hardening and Brazing at High Speed

THE NEED for speed — war's urgency — has established as thoroughly sound the surface hardening and heating of steel by electrical induction. Recognition of the inherent advantages possessed by this revolutionary method has proven to be a great stimulus to a young and fast expanding industry.

Wartime uses to which induction treatment is being applied include the brazing of high explosive shells, smoke bombs, incendiary bombs and burster tubes which require uniform, gas-tight joints between the various parts of the assembly. Heat can be confined to a narrow band while physical properties of balance of part remain unaltered. Shell blanks, propeller hubs and bomb casings are among a large list of pieces now being heated for shaping. Quantities run into hundreds per hour, each one heated free of scale.

A fast feeding fixture recently perfected for the neck annealing of cartridge cases rushes 30,000 pieces an hour through a special inductor that confines the heat to the necked area

alone. A sensational development for the hardening of armor piercing shot has placed a new tool into industry's hands. Imparting great penetrating power to the projectile, induction hardening allows for the use of more readily available steels with which to produce them in sizes ranging from 20 mm. to 75 mm.

And with the armed forces drawing away many shop men, electrical induction operations are functioning successfully with women at the controls. Skilled personnel is not essential. Induction heating has arrived.

William E. Benninghoff
Manager, Tocco Division
Ohio Crankshaft Co.

Faster Heat Treatment of Ordnance

OF THE MANY process-heating accomplishments stimulated by war's production demands and involving developmental engineering, the following three, perhaps, represent the greatest contribution of this firm to increased war production and the most fundamental potential influences upon future heat treating methods:

1. By special ceramic burners (and applications thereof in automatic *open* heat treating machinery) armor piercing shot is being successfully flame hardened on short cycles measured in minutes — as against conventional $1\frac{1}{4}$-hr. furnace hardening cycles. This new method, further, reduces the cost of the heat treating equipment, expedites installation, eliminates furnace heating-up times, and avoids scaling. The hardness "contours" within shot so treated can be controlled to suit exacting ballistic requirements.

2. Changeovers from rubber to steel treads for Army tank tracks brought about demands for surface hardening installations far in excess of available oxy-acetylene supplies and beyond the practical abilities of electric induction equipment. With burner equipment which permits gas-air combustion concentrations as high as 40,000,000 B.t.u. per hr. per cu.ft. of combustion space, tank treads are now surface hardened to specification at a production rate measured in seconds. Multiple units designed into automatic handling machines take care of immense requirements.

3. To produce cast-armored super-tanks in large numbers required the development of special huge radiant gas-fired furnaces capable of heat treating, on a continuous basis, one-piece hull castings weighing up to 25,000 lb. and measuring as much as 25 ft. long each. Restrictions on nickel and other scarce alloying metals without sacrifice of quality in the finished armor had to be met in the heat treatment — by extreme adaptability of both combustion and furnace equipment, and by observing extremely rigid limitations on temperature during all critical stages of complex heat treating cycles.

Frederic O. Hess
President
The Selas Co.

Expanding Use of Induction Heating

DURING the past six months Induction Heating Corp. has more than doubled its output of high frequency generators and has limited its entire output to the manufacturers and heat treaters of war material. The use of this equipment has proven extremely advantageous in the fabrication of armor piercing shot, chemical shells, aircraft engine parts, tanks, and practically every branch of the war production field. Education of the heat treating personnel has also been necessary on the art of induction heating, so we have issued a series of data sheets which are sent to any interested person. In this way there has been a general dissemination of knowledge of this fast growing subject throughout the industry.

J. W. Cable
Development Engineer
Induction Heating Corp.

Continuous Furnace Operation Demands Excellent Auxiliaries

THIS IS A WAR of metals, and an ever increasing demand is taxing the nation's resources to their utmost to produce the machines and equipment to win. The treatment of these metals, therefore, becomes of maximum importance for increased production of war products. This means heat treating furnaces must operate 24 hours a day, every day, in order

to get out the work needed to make projectiles, guns, tanks, planes and ships. Heat treating of the thousands of parts that go into these items is being handled faster than ever before due to the high quality of the furnace equipment and the auxiliaries as well. Low pressure blowers for combustion on oil-fired and gas-fired furnaces form an important part of this auxiliary equipment, and as such are doing their share in the war effort.

It has sometimes been necessary to substitute other materials, in the manufacture of these items, in place of critical aluminum and high alloy steel, and many interesting developments are being made along these lines. Simplified designs are also being arranged to eliminate any possible cause of shut down. The trend is toward individual air supply for each furnace, which increases the number of blowers required tremendously. Manufacturers of this type of equipment are meeting the demand with increased production.

R. A. BRACKETT
Sales Manager
Spencer Turbine Co.

Combustion Oil or Gas Fuel System

WHEN North American Manufacturing Co. started to build combustion equipment for metallurgical furnaces 25 years ago, America was in the first world war. At that time most liquid-fired or gas-fired metallurgical furnaces were controlled manually by individual fuel and air valves. Even a casual knowledge of furnace construction at the present day will indicate how far we have come in the meantime. Present-day burner equipment automatically controls the fuel-air ratio, resulting in greater combustion efficiency, higher flame temperature, more production. The recent demand for burner systems which will handle either gas or oil has caused us to develop several complete systems of combination equipment which allows the operator to change from one fuel to another by simply opening and closing valves in the fuel lines. Production is increased by eliminating the time lost in the fuel change-over and, more important, the war plants are no longer dependent upon one fuel supply. New burner designs with built-in gas and electric pilots make for safer and better automatic furnace control — quicker starting, less heating-up time, more production.

The ability of our product — or any product — to find a market is in direct relationship to the increased production and efficiency derived from the installation of the new equipment. The war does not change this.

GEORGE F. NAAB
Vice-President and General Manager
North American Manufacturing Co.

Sub-Zero Harnessed to War Products

PRODUCTION, on an industrial scale, of extreme sub-zero temperatures (in contradistinction to refrigeration near freezing temperatures) is a recent achievement, and its applications to metal working and ordnance production are even more recent. Likewise detailed information on the performance of the units in the aviation industry, in the tool and machinery field, and in the manufacture of rubber substitutes is still restricted and confidential. It is permissible, however, to mention the following items where Deepfreeze is contributing to the predominant aim of "More Production of War Products":

Extreme low temperatures are performing three highly important functions. The first is in the shrinking of metals, which makes possible slide fits assembled with the human hand which previously required powerful hydraulic presses. Not only is the work speeded up with less labor, but there are the added advantages of fewer rejections and fractured metals.

The second and equally important application of extreme low temperatures in metallurgy is that of developing unusual combinations of hardness, strength, and ductility by cooling tool-steel and alloy steel from a high temperature quench continuously down to below −100° F., and thus completing arrested transformations.

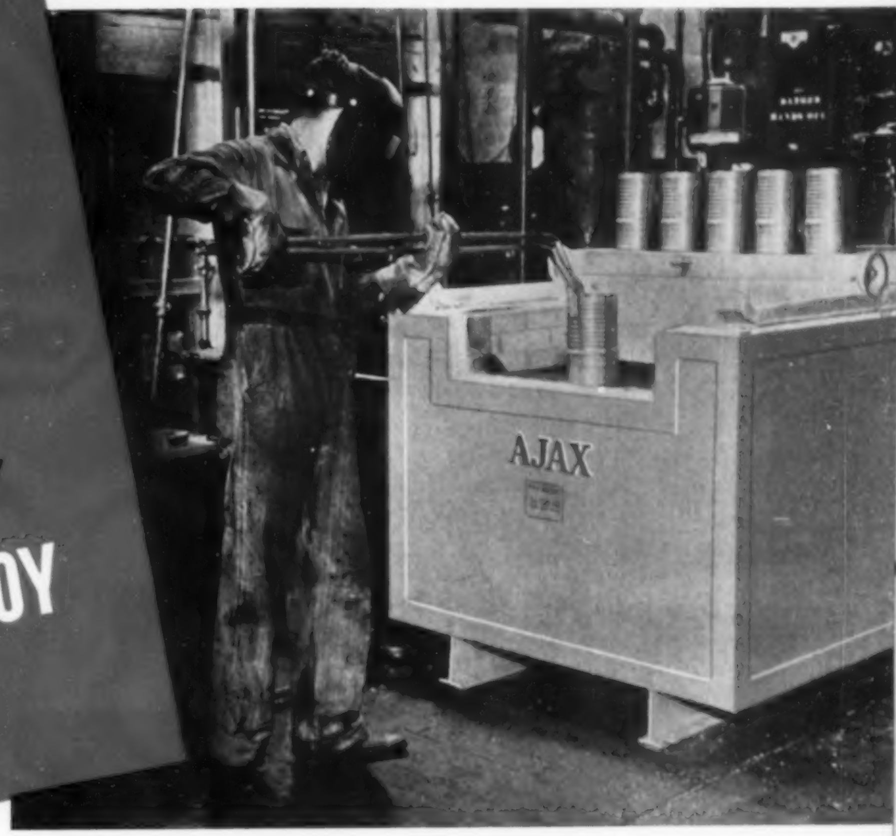
Third, it has also been found that precision gages will be much more stable in dimension if, after hardening in the approved manner, they are cooled or "counter-annealed" at sub-zero temperatures, below −100° F.

ALFRED C. HOUSER
Sales Promotion Manager
Motor Products Corp.
Deepfreeze Division

Why Salt Baths are THE LOGICAL WAY TO HARDEN

WITHOUT DECARB OR SCALE ✓
WITH MINIMUM DISTORTION ✓
AT FASTEST HEATING RATE ✓

CARBON AND ALLOY STEEL PARTS



Immersed in the salt bath at 1550 deg. F. and quenched over a mandril in oil, big cylinder sleeves shown hold diameters to .007" at output speeds of 120 in 8 hours, using the 65 kilowatt Ajax-Hultgren furnace illustrated above.

An Ajax-Hultgren furnace is the *logical* way to harden, because:

1. In hardening, a neutral molten bath "controls the atmosphere" by the simple process of eliminating it entirely. A salt film seals out deleterious gases right up to the instant of quenching, hence decarburization, oxidization, or scaling *cannot* occur. No other heating medium possesses this valuable characteristic.

2. A salt bath is the fastest heating medium for transferring heat to work. Therefore, an Ajax furnace will yield more completed heating cycles per day than any radiation or forced convection system.

3. Heating in an Ajax-Hultgren furnace is uniform at all points, hence distortion does not occur. This feature—based upon absolute and automatic temperature control—is an inherent characteristic of the furnace, and no other means will provide such temperature control and uniformity of heating within such narrow limits (5 deg. F. or less).

4. All forms of hardening in an Ajax-Hultgren furnace may be done selectively, as desired. This feature itself is only a partial demonstration of the great flexibility of these units as used in industry today.

It is only logical to find that there are now more than a thousand Ajax-Hultgren Electric Salt Bath Furnaces in use* for ... hardening armor plate, armor piercing shot, dies ... aircraft structures, steering gear assemblies, ordnance components, gears, high speed steel tools (up to 2400 deg. F.), etc.

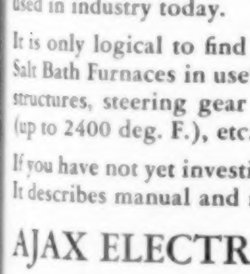
If you have not yet investigated Ajax-Hultgren applications, send at once for Catalog 107-A. It describes manual and mechanized installations, from 35 to 750 kilowatts in size.

AJAX ELECTRIC COMPANY, INC. FRANKFORD AVE. AT DELAWARE AVE. PHILADELPHIA, PA.

HERE ARE THE KEY PROCESSES TODAY...

CARBURIZING
SIMULTANEOUS BRAZING & CARBURIZING
NEUTRAL HARDENING
CYANIDE HARDENING
SELECTIVE HEATING
AGE HARDENING
TEMPERING
HARDENING HIGH SPEED STEEL TOOLS
ANNEALING
BRAZING
HEATING FOR FORGING

*THERE'S AN AJAX-HULTGREN INSTALLATION NEAR YOU



THE AJAX HULTGREN ELECTRIC SALT BATH FURNACE

ASSOCIATE COMPANIES:
AJAX METAL COMPANY, *Non-Ferrous Ingot Metal for Foundry Use*
AJAX ELECTRIC FURNACE CORPORATION, *Ajax-Wyatt Induction Furnaces for Melting*
AJAX ELECTROTHERMIC CORPORATION, *Ajax-Northrup Induction Furnaces for Melting, Heat-Treating*

Factors Influencing Austenitic Grain Size*

By Thomas G. Digges and Samuel J. Rosenberg

IN THE DISCUSSION of a paper by the present authors on the effect on the austenitic grain size of the rate of heating through the transformation range, presented to the ⚙ 1940 Convention (*Transactions*, Vol. 29, p. 638), J. R. Vilella summarized experience with commercial steels thus:

"Increasing the heating rate tends to coarsen the austenite grains but the degree of coarsening varies considerably between different heats. No instance of refinement of the austenite grains as a result of fast heating has been observed. The temperature to which the steel is heated is another important factor; the coarsening effect of rapid heating is more pronounced the nearer this temperature approaches that at which the steel coarsens on normal or slow heating."

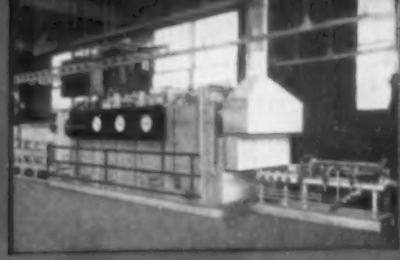
The original paper above mentioned described experiments with an iron-carbon alloy of exceptional purity, containing 0.50% carbon, less than 0.031% of identifiable impurities, and no detectable alumina or aluminum. We found that this synthetic alloy reacted generally like the commercial steels, namely, the grain size at 1475, 1500 and 1600° F. increased with decrease in rate of heating, whereas the grain size at 1800° F. was not so noticeably dependent upon the rate of heating. Coarser grains were produced at the lower temperatures with slow rates of heating than at higher temperatures with fast rates of heating. With slow heating, coarse grains of the same order of magnitude were obtained at all temperatures.

Experiments with commercial steels and alloys of high purity indicate that the grain size of some of them is sensitive to the rate of heating. All, however, did not respond in the same manner. Therefore grain size specifications should consider the rate of heating through the transformation range.

It was also recognized that initial structure — fine, coarse, or spheroidized pearlite — was also a factor, and work has been extended to clear up this point, if possible. Results are contained in Research Paper 1481. In this work, the 0.50% iron-carbon alloy of high purity was studied, as well as (*Continued on p. 612*)

*Abstract of Research Papers No. 1481 and 1489 respectively, published in *Journal of Research* of the National Bureau of Standards, July 1942, page 33, and August 1942, page 113.

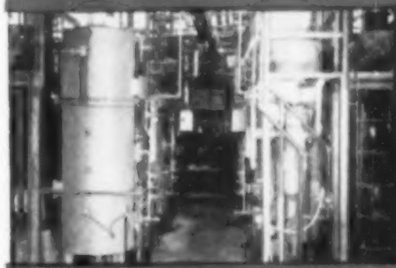
ROTARY HEARTH—This furnace is recommended for parts that require individual handling. Used largely to heat-treat gears, and similar work.



PUSHER FURNACE

CAR-BOTTOM FURNACE

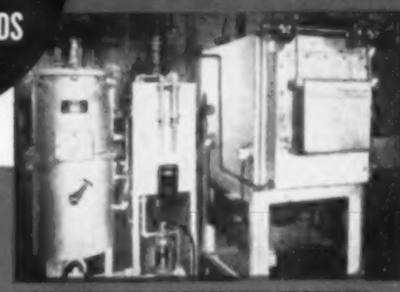
BOX-TYPE FURNACE



ATMOSPHERE EQUIPMENT

PIT FURNACE

CARBURIZING FURNACE



BOX FURNACE & DRYCOLENE PRODUCER

4 Reasons Why G-E Furnaces Assure Fast Heat Treating

1. Continuous Operation

No handling of the parts is required from the time they are put into the furnace until they are discharged. One continuous and complete operation puts all parts through same temperature, same atmosphere, and same time cycle. This assures high uniformity and fast mass production.

2. Scale-free Work

All of these furnaces can be used with protective atmosphere, thus eliminating subsequent cleaning operations. Time and labor are not wasted in rejections and inspections.

3. Little Operation Labor

After loading the work on conveyors, automatic controls put it through the proper time, atmosphere, and temperature cycles. Elimination of handling speeds operation and saves valuable labor.

4. High Heating Efficiency

Easy confinement of heat within the furnace assures low heat losses. Provides comfortable working conditions, too. Thus, valuable time is not wasted.

Have You a Heat-treating Problem?

These mass-production furnaces are built to do your heat treating uniformly and fast and to stay on the job. They are available in standard designs; specials can be designed to fit your needs. For more information get in touch with the nearest G-E office. Our engineers will make a study of your problem and recommend the furnace for the job, selected from dozens of tested and proved types. *General Electric, Schenectady, N. Y.*

MORE THAN 30 TYPES OF FURNACES FOR INDUSTRIAL NEEDS

The Navy "E", for Excellence, has been awarded to 92,780 General Electric employees in six plants manufacturing naval equipment.

GENERAL ELECTRIC

Grain Size

(From p. 608) two 0.50% carbon steels of representative commercial heats differing principally in the amounts of aluminum oxide and aluminum. One with 0.0025% total aluminum was produced under conditions which resulted in non-control of austenitic grain size, whereas the other with 0.0195% total aluminum was controlled.

The iron-carbon alloy was treated for three different initial structures, namely, coarse pearlite, fine pearlite (sorbite), and spheroidized cementite. (In the spheroidized structure carbides coalesced in a network.)

Each of the two commercial steels was treated to give initial structures differing in the interlamellar spacing of pearlite or in the form and distribution of the carbides. These initial structures were: Coarse pearlite obtained by annealing at 1700° F.; medium pearlite obtained by air cooling after hot rolling; fine pearlite (sorbite) formed by isothermal reaction at 1010° F.; bainite formed isothermally at 735° F.; and spheroidized cementite produced by prolonged heating of sorbitized steel in the range 1200 to 1300° F.

The experimental procedure consisted in heating specimens, approximatly $\frac{1}{16}$ in. square by 0.04 in. thick, by plunging in a lead bath or heating in vacuum at various rates to 1475 or 1600° F. Specimens were held at top temperature for 15 min. and then cooled in a manner suitable for delineating austenite grains. A.S.T.M. grain sizes were determined on duplicate pieces and tabulated, and it was found that both initial structure and rate of heating can affect the grain size at a particular temperature. Of these two variables, the data indicate that the rate of heating is the more important, and is especially pronounced in the iron-carbon alloy. Although very rapid rates of heating form rather small austenitic grains in this alloy, slow rates of heating caused extremely coarse grains.

From a commercial viewpoint, fortunately, the two steels investigated did not exhibit the same habit as just described for the pure alloy. Only slight differences in grain size were obtained with variations in initial structure and rate of heating. A definite correlation between initial structure and grain size could not be established. However, some indication of a correlation between the rate of heating and the grain size could be observed; the slow rates often caused the formation of the smaller austenitic grains. This trend was slight in the case of the noncontrolled steel, but was more marked in (Cont. on page 616)

Grain Size

(*Starts on p. 608*) the controlled steel. Attention should be directed to the fact that the rate of heating not only had a much more pronounced effect upon the grain size of the iron-carbon alloy than upon the steels, but that the effect was *opposite* in the two materials. Wherever the rate of heating was of influence, the finest grains were obtained with slow rates.

The iron-carbon alloy used in this investigation was also utilized in a study of the mechanism of the transformation of different initial structures to austenite, and the results are contained in the Research Paper No. 1489. Nucleation and growth of the austenite were studied by differentially heating small specimens in vacuum at various rates to within and slightly above the Ac_1-Ac_3 transformation range and quenching directly in helium.

On heating a structure of fine pearlite plus ferrite, austenite was nucleated at the interfaces of ferrite and carbide, preferentially at the boundaries of pearlite and pro-eutectoid ferrite and at the boundaries of the pearlite colonies. Fingerlike growths occurred, usually in the directions of the lamellas.

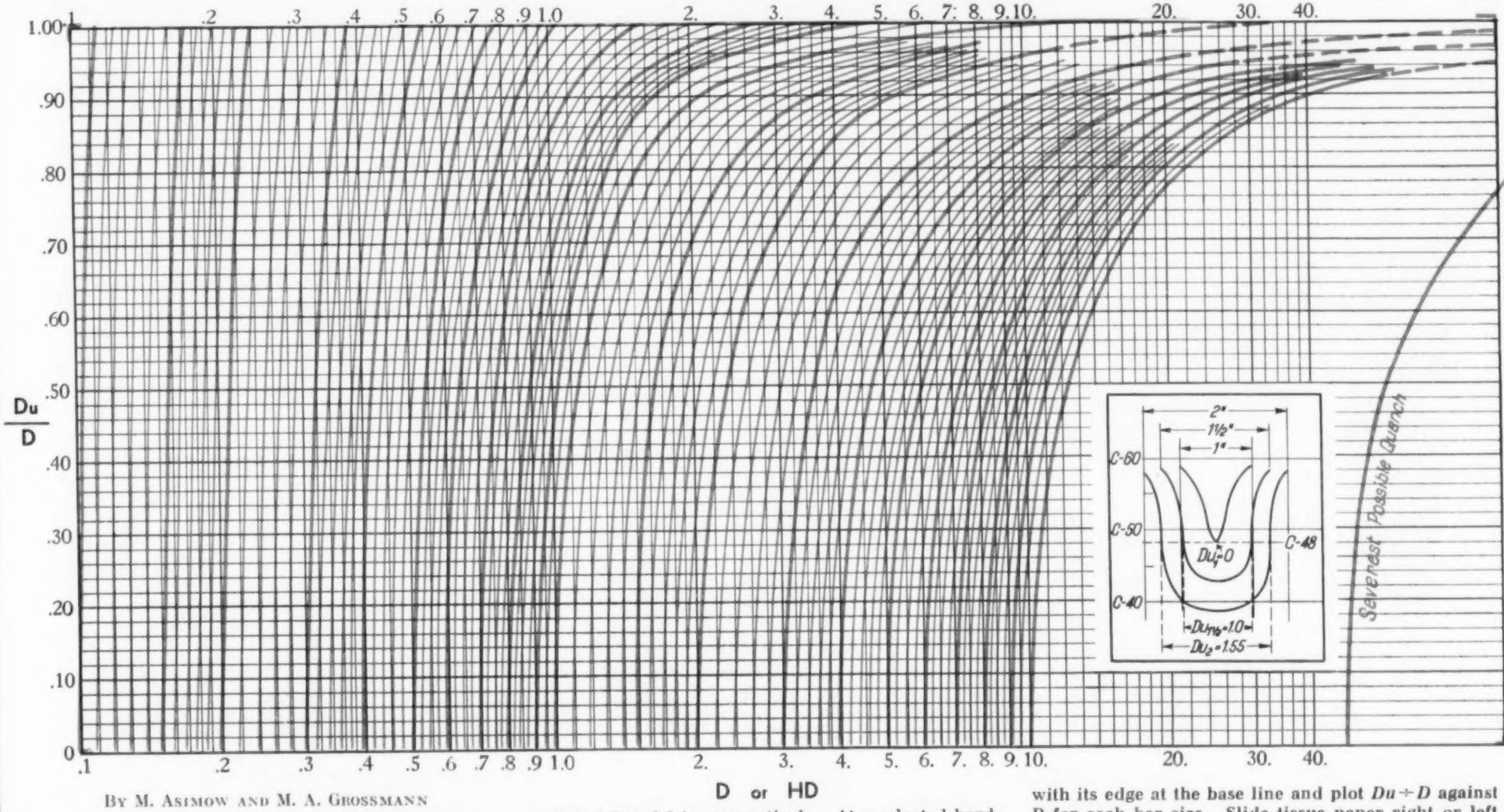
During spheroidization of this alloy the carbides tended to collect in the form of a network. On heating a specimen with such a structure, austenite started to form at ferrite-carbide interfaces, usually at the cementite network and to some extent within the network, and at first grew preferentially along the cementite network.

During the formation of austenite from fine, carbon-poor pearlite or an aggregate of spheroidized cementite and ferrite, the carbon diffused through ferrite to the austenite grains and also through the austenite during the absorption of the ferrite.

Regardless of the rate at which this alloy was heated through the Ac_1 transformation, austenite was nucleated at numerous interfaces of ferrite and carbide, so that in the initial stage of its formation the austenite was *always* fine grained. However, rapid grain growth may occur in the Ac_1-Ac_3 transformation range by the absorption or coalescence of the grains initially formed. If the rate of heating through the transformation range is extremely rapid, grain growth may be inhibited, and the austenite will be relatively fine grained considerably above Ac_3. If heating is less rapid, grain growth is not inhibited, and the austenite is very coarse grained. The predominant factor in establishing the final austenitic grain size of this alloy, therefore, is the rate of growth and not the rate of nucleation.

Cooling Power of Quenching Baths

Curves whereby severity of quench (heat transfer equivalent H) can be estimated. Copyright, 1939, Carnegie-Illinois Steel Corp.



By M. Asimow and M. A. Grossmann

To use this chart, harden *at least* three bars of various diameters in the given medium at working temperature and circulation, and determine curves of hardness distribution, edge to axis, at midlength. In the example sketched in the inset above, *D* is 1, 1.5 and 2 in. respectively. At a selected hardness horizontal, as C-48, which intersects or touches all curves, determine the ratio $Du \div D$ between soft center and bar diameter. (Soft center diameter *Du* is 0, 1.0 and 1.55 in.; $Du \div D$ is 0, 0.66 and 0.77 respectively.) Lay a piece of tissue paper over the chart with its edge at the base line and plot $Du \div D$ against *D* for each bar size. Slide tissue paper right or left until these points fall on a single curve, which for this quench happens when D_1 is at 5.0 and $D_{1.5}$ is at 7.5 (these now being values of *HD*). Then *H*, the severity of this quenching set-up, is $HD \div D$ or $5.0 \div 1.0$ or 5.0 (or $7.5 \div 1.5$ which gives the same result).

Combustion of Common Gases

Adapted (by permission) from tables in 1942 issue of American Gas Handbook

Material	Formula and Reaction	Molecular Weight	Specific Gravity (Air = 1.0)	Density at 60° F., 30 In. Barometer: Lb./Cu.Ft.	Density: Cu.Ft./Lb.	Specific Heat (H_2O = 1.0)	Heat of Combustion, B.t.u. per Cu.Ft.: Gross	B.t.u. per Cu.Ft.: Net	B.t.u. per Lb.: Gross	B.t.u. per Lb.: Net	Cu.Ft. per Cu.Ft. Combustible, Required for Combustion: Air	Required: O_2	Products of Combustion in Air: CO_2	Products: H_2O	Products: N_2
Carbon, C (to CO)	$C+\frac{1}{2}O_2=CO$	12.010	.....	......	.....	....	......	......	3,958	3,958	2.382*	0.5*	1.0* CO	...	1.882*
Carbon, C (to CO_2)	$C+O_2=CO_2$	12.010	.....	......	.....	....	......	......	14,092	14,092	4.764*	1.0*	1.0*	...	3.764*
Carbon monoxide, CO	$CO+\frac{1}{2}O_2=CO_2$	28.010	0.9672	0.07405	13.504	0.2478	321.7	321.7	4,345	4,345	2.382	0.5	1.0	...	1.882
Carbon dioxide, CO_2		44.010	1.5291	0.11707	[illegible]	0.1989	......	......	.....	.....	....	...	...	...	......
Hydrogen, H_2	$H_2+\frac{1}{2}O_2=H_2O$	2.0160	0.06952	0.005323	187.874	3.389	325.0	274.6	61,061	51,589	2.382	0.5	...	1.0	1.882
Paraffin Series, C_nH_{2n+2}															
Methane, CH_4	$CH_4+2O_2=CO_2+2H_2O$	16.042	0.5545	0.04245	23.557	0.5284	1,014.4	913.3	23,896	21,515	9.528	2.0	1.0	2.0	7.528
Ethane, C_2H_6	$C_2H_6+3\frac{1}{2}O_2=2CO_2+3H_2O$	30.068	1.0493	0.08034	12.447	0.3861	1,794	1,641	22,330	20,430	16.674	3.5	2.0	3.0	13.174
Propane, C_3H_8	$C_3H_8+5O_2=3CO_2+4H_2O$	44.094	1.562	0.11962	8.360	0.365	2,593	2,386	21,675	19,942	23.820	5.0	3.0	4.0	18.820
n-Butane, C_4H_{10}	$C_4H_{10}+6\frac{1}{2}O_2=4CO_2+5H_2O$	58.120	2.086	0.1597	6.263	0.351	3,405	3,142	21,321	19,678	30.966	6.5	4.0	5.0	24.466
Iso-Butane, C_4H_{10}	$C_4H_{10}+6\frac{1}{2}O_2=4CO_2+5H_2O$	58.120	2.068	0.15833	6.316	0.351	3,368	3,108	21,271	19,628	30.966	6.5	4.0	5.0	24.466
n-Pentane, C_5H_{12}	$C_5H_{12}+8O_2=5CO_2+6H_2O$	72.146	2.49*	0.1907*	5.245*	....	4,023*	3,720*	21,101	19.513	38.112*	8.0*	5.0	6.0	30.112
n-Hexane, C_6H_{14}	$C_6H_{14}+9\frac{1}{2}O_2=6CO_2+7H_2O$	86.172	2.97*	0.2277*	4.392*	....	4,771*	4,418*	20,954	19,402	45.258*	9.5*	6.0	7.0	35.758
Olefin Series, C_nH_{2n}															
Ethylene, C_2H_4	$C_2H_4+3O_2=2CO_2+2H_2O$	28.052	0.9748	0.07464	13.398	0.3592	1,615	1,513	21,638	20,277	14.292	3.0	2.0	2.0	11.292
Propylene, C_3H_6	$C_3H_6+4\frac{1}{2}O_2=3CO_2+3H_2O$	42.078	1.481	0.11339	8.819	....	2,380	2,226	20,990	19,629	21.438	4.5	3.0	3.0	16.938
Butylene, C_4H_8	$C_4H_8+6O_2=4CO_2+4H_2O$	56.104	1.935	0.14815	6.750	....	3,079	2,877	20,780	19,419	28.584	6.0	4.0	4.0	22.584
Aromatic Series, C_nH_{2n-6}															
Benzene, C_6H_6	$C_6H_6+7\frac{1}{2}O_2=6CO_2+3H_2O$	78.108	2.712*	0.2076*	4.816*	....	3,758*	3,606*	18,100(a)	17,367(a)	35.730*	7.5*	6.0	3.0	28.230
Toluene, C_7H_8	$C_7H_8+9O_2=7CO_2+4H_2O$	92.134	3.178*	0.2433*	4.110*	....	4,453*	4,251*	18,300(a)	17,471(a)	42.876*	9.0*	7.0	4.0	33.876
Xylene, C_8H_{10}	$C_8H_{10}+10\frac{1}{2}O_2=8CO_2+5H_2O$	106.160	3.662*	0.2803*	3.567*	....	5,189*	4,937*	18,510(a)	17,610(a)	50.022*	10.5*	8.0	5.0	39.522
Acetylene, C_2H_2	$C_2H_2+2\frac{1}{2}O_2=2CO_2+H_2O$	26.036	0.9073	0.06947	14.395	0.3832	1,491	1,440	21,460	20,727	11.910	2.5	2.0	1.0	9.410
Naphthalene, $C_{10}H_8$	$C_{10}H_8+12O_2=10CO_2+4H_2O$	128.164	.....	......	.....	....	......	......	17,280(b)	16,684(b)	57.168*	12.0*	10.0	4.0	45.168
Ammonia, NH_3	$NH_3+\frac{3}{4}O_2=\frac{1}{2}N_2+1\frac{1}{2}H_2O$	17.032	0.5963	0.04566	21.903	0.5232	442	365	9,678	7,996	3.573	0.75	...	1.5	3.323
Nitrous oxide, N_2O		44.016	1.530	0.11716	8.536	0.2004	......	......	.....	.....	....	...	...	...	......
Nitric oxide, NO		30.008	1.0367	0.07937	12.599	0.2329	......	......	.....	.....	....	...	...	...	......
Hydrogen sulphide, H_2S	$H_2S+1\frac{1}{2}O_2=SO_2+H_2O$	34.076	1.194	0.0914	10.972	0.243	649	598	7,100	6,539	7.146	1.5	1.0 SO_2	1.0	5.646
Sulphur dioxide, SO_2		64.060	2.2637	0.17331	5.770	0.1516	......	......	.....	.....	....	...	...	...	......
Water vapor, H_2O		18.016	0.6221*	0.04763*	20.995*	0.482	......	......	.....	.....	....	...	...	...	......
Oxygen, O_2		32.0000	1.1053	0.08463	11.817	0.2178	......	......	.....	.....	....	...	...	...	......
Nitrogen, N_2		28.016	0.9673	0.07406	13.503	0.2477	......	......	.....	.....	....	...	...	...	......
Nitrogen ("Atmospheric") (c)		28.161	0.9721	0.07443	13.436	0.246	......	......	.....	.....	....	...	...	...	......
Air (d)		.....	1.0000	0.07656	13.061	0.2400	......	......	.....	.....	....	...	...	...	......

Typical Commercial Gases

Kind of Gas	Constituents of Dry Gas—% by Volume: CO_2	Ill.	O_2	CO	CH_4	C_2H_6	H_2	N_2	Specific Gravity (Air = 1.0)	Lb./Cu.Ft.	Cu.Ft./Lb.	Specific Heat	B.t.u. per Cu.Ft.: Gross	Net	B.t.u. per Lb.: Gross	Net	Required: Air	Required: O_2	Products: CO_2	Products: H_2O	Products: N_2
Natural gas																					
San Joaquin, Cal.	0.1	...	...	...	98.7	...	...	1.2	0.560	0.0429	23.32	....	1,002	902	23,368	21,036	9.40	...	0.987	1.974	7.442
Texas Panhandle	0.1	(e)	0.1	...	82.2	6.1	...	7.7	0.660	0.0505	19.79	....	1,055	954	20,876	18,878	9.88	...	1.076	9.997	7.882
Gulf Coast	0.2	...	1.0	...	88.8	2.3	...	7.7	0.610	0.0467	21.41	....	942	849	20,168	18,177	8.80	...	0.934	1.845	7.027
West Virginia	0.8	...	...	...	75.0	23.1	...	1.1	0.680	0.0521	19.21	....	1,175	1,064	22,572	20,439	11.00	...	1.212	2.193	8.700
Coal gas																					
Horizontal retort	2.1	3.8	0.4	8.7	28.2	2.8	50.5	3.5	0.431	0.0330	30.30	....	612	549	18,544	16,635	5.32	...	0.568	1.240	4.241
Horizontal retort	2.8	4.5	0.6	7.4	34.3	...	41.6	8.8	0.493	0.0377	26.49	....	606	545	16,053	14,437	5.33	...	0.589	1.206	4.299
Vertical retort	3.0	3.1	0.6	7.0	32.8	...	50.4	3.1	0.410	0.0314	31.85	....	587	525	18,698	16,723	5.10	...	0.527	1.231	4.060
By-product coke oven gas	2.1	3.2	0.4	5.0	30.3	...	52.9	6.1	0.400	0.0306	32.65	....	566	505	18,480	16,488	4.90	...	0.476	1.209	3.935
Water gas																					
Carburetted with gas oil	3.3	10.7	0.7	33.4	10.0	...	38.1	3.8	0.651	0.0498	20.06	....	563	520	11,294	10,431	4.76	...	0.799	0.827	3.822
Carburetted (heavy oil)	4.6	10.3	0.6	24.1	9.0	2.2	32.5	16.7	0.710	0.0544	18.39	....	535	494	9,841	9,087	4.60	...	0.740	0.808	3.825
Uncarburetted	6.2	...	0.3	39.2	2.3	...	49.0	3.0	0.550	0.0421	23.75	....	309	282	7,337	6,698	2.31	...	0.477	0.536	1.852
Oil gas	3.0	4.0	0.6	9.7	28.1	...	50.2	4.4	0.440	0.0337	29.68	....	568	509	16,859	15,108	4.90	...	0.536	1.156	3.912
Producer gas																					
Anthracite coal	6.6	0.3	...	25.1	0.3	...	18.7	49.0	0.837	0.0641	15.60	....	151	141	2,356	2,200	1.13	...	0.330	0.200	1.386
Bituminous coal	2.5	0.4	0.3	27.0	2.5	...	12.0	55.3	0.866	0.0663	15.08	....	160	151	2,413	2,277	1.23	...	0.333	0.179	1.529
Blast furnace gas	9.4	...	...	27.8	...	...	1.0	61.8	1.006	0.0770	12.98	....	93	92	1,207	1,196	0.69	...	0.372	0.010	1.160

Notes: *Figure calculated on assumption that substance could exist as gas at 60° F. and 30 in. of mercury.

(a) Liquid
(b) Solid
(c) Contains 0.94% argon by volume, about 0.03% CO_2 and trace of hydrogen.

(d) Purified, dry air contains 20.99% oxygen and 79.01% nitrogen and other inert gases by volume (or 23.20% oxygen and 76.80% nitrogen by weight).
(e) 2.4% C_3H_6, 1.4% C_4H_8.

Hardenability Calculated From Composition

By Marcus A. Grossmann

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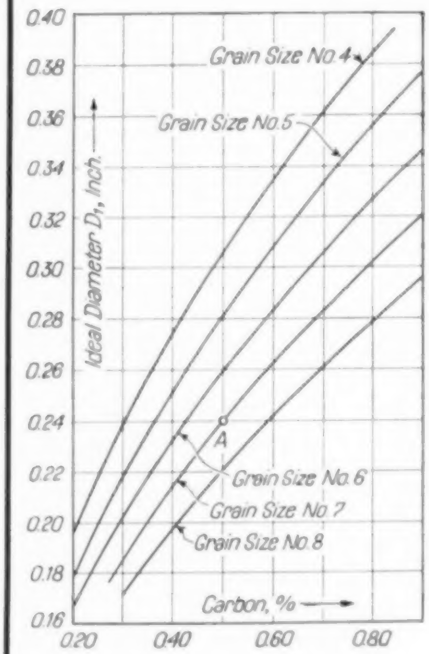
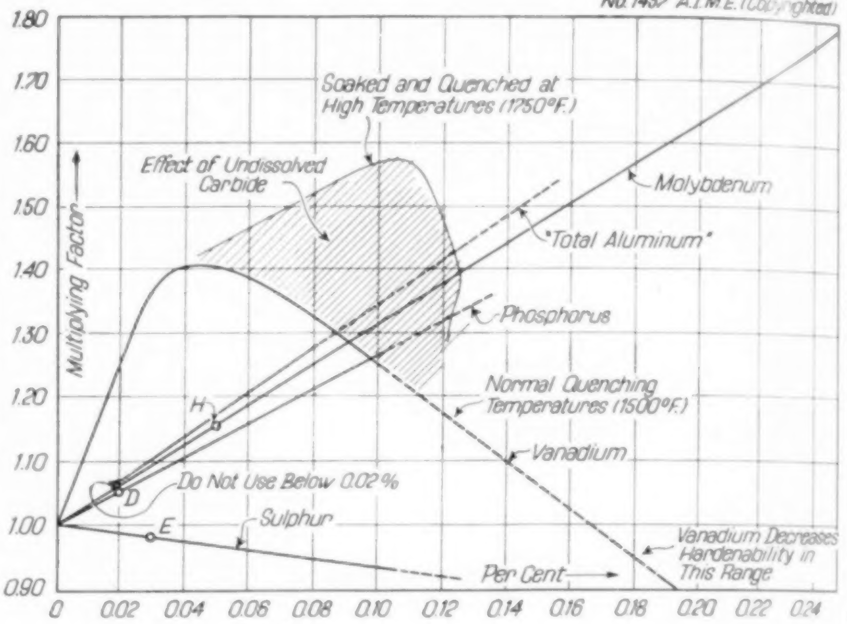
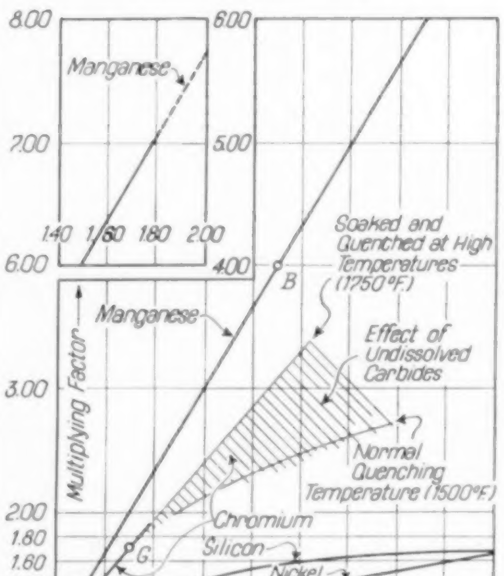
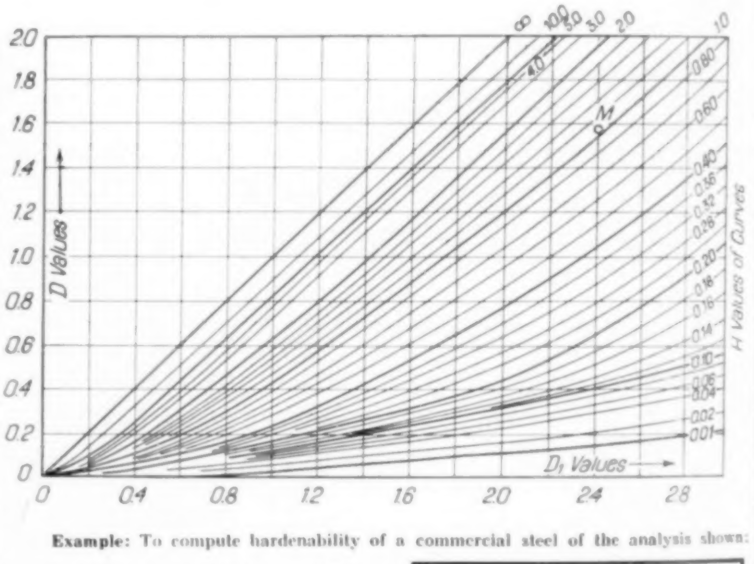
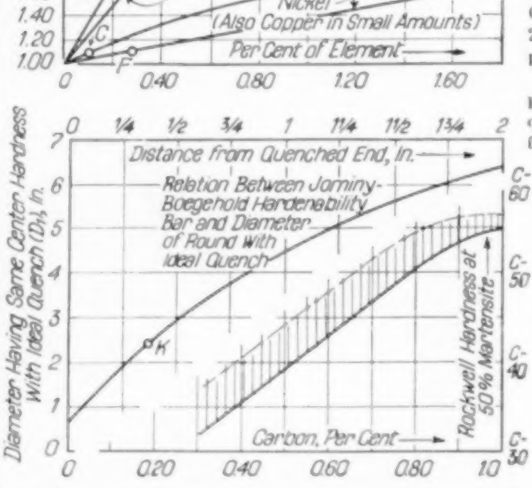










Example: To compute hardenability of a commercial steel of the analysis shown:

Ideal hardenability of given steel = D_1 = 0.24×4×1.1×1.05×0.98×1.1×1.7×1.16×1.02 = 2.40. Such figures for D_1 will accurately compare one steel with another.

Jominy equivalent of the given steel at point *K*, that is, hardness of center of ideally quenched 2.40-in. bar, is the same as that found 3/8-in. from end of end-quenched specimen.

Actual hardness at center, taken from lowest curve, is about C-45 for 0.50 carbon, low alloy steel.

Item	Amount	Factor	Point
Grain size	7	0.24	*A*
Carbon content	0.50		
Manganese	0.90	4.00	*B*
Silicon	0.10	1.10	*C*
Phosphorus	0.020	1.05	*D*
Sulphur	0.029	0.98	*E*
Nickel	0.28	1.10	*F*
Chromium	0.30	1.70	*G*
Molybdenum	0.05	1.16	*H*
Copper	0.05	1.02	*

*Estimated on the line for nickel.

Quenching power H of commercial baths may be determined by methods shown in the data sheet, Metal Progress, Oct. 1941, page 520, or estimated from the table at right, below.

Example: Water quench, mildly agitated; H = 1.05; Steel D_1 = 2.40. Actual critical diameter D (from point *M* above D_1 = 2.40) is $1\frac{9}{16}$ in., size of bar of given steel that will harden in given quench to half martensitic structure at center; hardness C-45.

Circulation or Agitation	Value of H for		
	Oil	Water	Brine
None	0.25 to 0.30	0.9 to 1.0	2
Mild	0.30 to 0.35	1.0 to 1.1	2 to 2.2
Moderate	0.35 to 0.40	1.2 to 1.3	....
Good	0.4 to 0.5	1.4 to 1.5	....
Strong	0.5 to 0.8	1.6 to 2.0	....
Violent	0.8 to 1.1	4	5

Non-Ferrous Metals

Minor Metals Fairly Plentiful

AMONG the more important non-ferrous metals in the strategic group, not discussed elsewhere, are antimony, mercury and platinum, each of which plays an important part in the war program.

Antimony — The bulk of the country's antimony supply now comes from ores imported from Mexico and South America. Most of the Mexican ore (two-thirds of the supply) goes to the smelter at Laredo, Texas, but a small tonnage of antimony-mercury ore is treated at a plant near Los Angeles, Cal.; the South American ores are largely made into antimony oxide. With the closing of the Burma road, no more Chinese metal can be expected. Fortunately, there has been some expansion of ore production from domestic mines, part of which has been treated at the new recovery plant built in Idaho by the Bunker Hill Smelter. Two exploratory projects of the U. S. Bureau of Mines and the Geological Survey resulted in the discovery of some 2,000,000 tons of ore carrying an estimated 47,500 tons of antimony. The most important new project is in the Yellow Pine district of Idaho, where antimony ore has been found in large amounts.

Antimony metal's principal use is as a hardening element in lead and in bearing alloys. In the last war vast quantities of hardened lead were used for shrapnel bullets, and this demand does not now exist. Similarly, excellent bearings containing little or no antimony are now well known. Consequently it is likely that we can readily provide enough antimony for our essential uses.

Mercury — The mercury industry of the United States is outstanding, in that it is the only one in the strategic group of metals which has been able to build up practically full self-sufficiency. The U. S. Bureau of Mines estimated the 1941 output at 44,000 flasks (of 76 lb. each), against 37,777 flasks in 1940 and 18,633 flasks in 1939. This record has been made only under extreme difficulties, involving the treatment of virgin ores carrying as little as 3 lb. of mercury per ton, and of reclaimed dump ore of less than half that tenor.

The prevailing high price and the heavy demand have stimulated the search for new ore, and several mines have materially supplemented their reserves. Also exploratory prospecting has discovered new deposits in Idaho and Nevada.

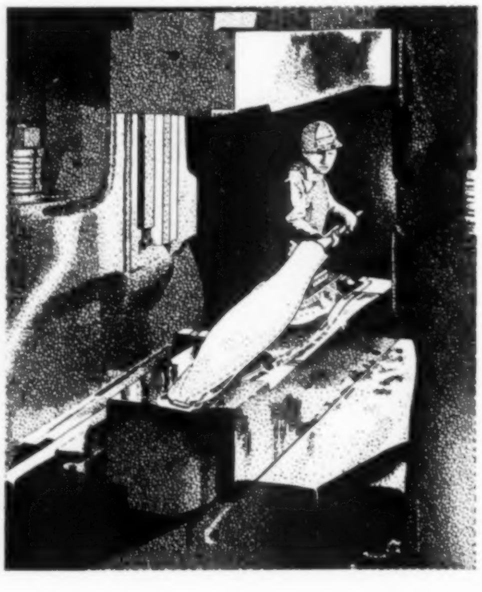
Platinum Group Metals — War demand has greatly increased the use of platinum group metals; of platinum, as a catalyst in the production of nitric and sulphuric acids, as metal extrusion dies for rayon and glass wool, electrical contacts and temperature-measuring and control devices, and especially in platinum clad equipment in the chemical industries; of palladium in catalysts for the hydrogenation of organic compounds and in dental alloys; of iridium as a hardener for platinum alloys required for many of the above uses; and of ruthenium as a hardener in jewelry alloys, freeing the iridium formerly used for more essential uses. American sources are the Alaskan placers, and residues from copper and gold refineries. The world's most important source is the platinum bearing slimes from the Canadian nickel refinery, formerly sent to England for refining, but now brought to the United States refineries in large amounts. Including the Russian placer platinum, almost the entire world output of platinum metals is at the disposal of the United Nations, while the entire amount directly available to the Axis powers is limited to a few hundred ounces annually; their usage must be confined to stocks on hand, seizures in occupied areas, and such small amounts as can be smuggled through the blockade.

GAR A. ROUSH
Editor
The Mineral Industry

Seven Times as Much Aluminum

IN TIMES OF PEACE, there has been enough aluminum in America for all the pots and pans, trucks and stream-line trains and the thousand and one other uses for which there was a demand. When the first war clouds appeared in Europe and long before December 7th, the Aluminum Co. of America anticipated a tremendous increase in the need for aluminum. The company therefore started to expand production facilities, and this self-financed expansion program, described in July METAL PROGRESS by T. D. Jolly, has now cost $250,000,000.

Even this big increase in capacity was much too small to take care of the vast aviation program first announced by President Roosevelt on May 16, 1940, and since expanded to the production of 185,000 planes in 1942 and 1943. Not only did aluminum have to be produced for aircraft but for the hundreds of other uses for the metal in war times, but as the result of intelligent planning and construction, there will be available before the end of 1943 *seven* times the capacity for ingot aluminum which the country had in 1938.



New plants financed by the Government are either completed or under way, and all will be operating a year from now. The majority of these Government plants are being built by the Aluminum Co. of America without profit, and will be operated by the Company for a modest fee. Reynolds Metals Co. is producing aluminum at its plants in Alabama and in the North-West, and the Olin Corp. has a plant in the State of Washington.

All of these plants will not only provide an annual aluminum ingot capacity in the United States of 2,100,000,000 lb., but also the facilities for producing aluminum in fabricated form, such as the plate, sheet, rod, castings and forgings needed for military and naval equipment.

S. K. COLBY
Vice-President
Aluminum Co. of America

Reducing Amount of Circulating Metal in Process

ASIDE from its achievement in building and operating a large plant in Alabama for the reduction of aluminum ingot from bauxite ore, thus not only presenting American customers with a second source of aluminum but also augmenting our annual production of this "precious metal", Reynolds Metals Co. has the only plant in America which starts with bauxite and ships out aluminum fabricated products and finished aircraft skins or sheared parts, thus avoiding the costly shipping of surplus metal, re-shipping scrap, and long delays. This sound economic plan has the following advantages, and if pursued to its logical limit, would represent a surprising increase in the number of airplanes built from a given amount of aluminum.

1. An average of 30% of all prime sheet shipped to airplane builders is utimately returned as scrap. Finished parts shipped from the sheet sources would therefore *(a)* reduce the freight on the original shipment by 30%, and *(b)* eliminate unnecessary handling and inspection, conserve plant space, and eliminate freight on scrap returns.

2. Sheet scrap remains at the source *(a)* ready for instant remelting, recasting and rerolling, *(b)* carefully segregated as to alloying elements and *(c)* kept clean and uncontaminated.

3. Duplication of facilities is avoided because parts for many builders are made at the source, on a single set of mass production tools, and short runs on semi-automatic machines at isolated plants are eliminated. Identical shapes for a number of builders are economically produced on a volume basis.

4. Skilled labor at the airplane plants is released for more important work.

Surveys have shown that 9,000,000 lb. of prime sheet is now on its way to aircraft companies as potential scrap; 18,000,000 lb. of this

potential scrap is in inventory and "in flow", metal actually in the aircraft plants; and 9,000,000 lb. on its way back to the source for re-processing. These three items tie up a total of 36,000,000 lb. of aluminum alloy sheet.

One of our contributions to the major objective of Increased Production of War Products will be, by the integrated operation of the Reynolds' plants in Alabama and Kentucky, the demonstration — by the production of parts to airplane manufacturers' templates — that the old routine is futile and should be abandoned.

HARRY J. HUESTER
Technical Adviser
Reynolds Metals Co.

Light Metal Castings in Triple Number

WHEN WAR clouds began to gather, this organization foresaw a tremendously increased need for aluminum and magnesium alloy castings with their peculiar and special advantages. As a pioneer in the development of castings of these important alloys, Aluminum Industries inaugurated an extensive building program. Even before Pearl Harbor, the first new units were in full operation. Now, hundreds of added employees, in four large plants, working in three shifts, are doing their part to support the boys on the firing line.

In laying out these plants the best engineering experience was called upon to replace, in every possible operation, former foundry practices with the latest production-line methods for speeding output while maintaining quality. As a result, output has more than trebled, and the production curve still rises.

Our "Permite" castings of aluminum and magnesium alloys, made by permanent molds, semi-permanent molds, and sand molds, are going into innumerable types of war equipment where they provide the advantages of light weight, strength and resistance to corrosion. They are used in building bombers, pursuit ships and other aircraft, submarines, communication equipment, airfield equipment, radio equipment, ships, tanks, jeeps, blitz wagons, trucks — and many types of ordnance production equipment, including machine tools. In fact, every day is uncovering new needs for these strong, light weight castings in combat and production equipment, destined to translate America's long recognized industrial supremacy into equally unquestioned military supremacy.

M. A. BECKMANN
Vice-President
Aluminum Industries, Inc.

Magnesium Becomes a Vital Structural Metal

THE STORY of magnesium in 1942 graphically illustrates the change in character of military operations since 1918.

In the entire last year of World War I the United States consumed 284,000 lb. of magnesium, practically all for flares, tracers and other pyrotechnic uses. Today, this figure of approximately one-quarter million more nearly represents *daily* production and consumption, and many new plants are yet to start up.

Back of these figures is the advance and development of the airplane as a major fighting unit of this war, and back of this, in turn, is the tremendous technical and industrial developments in the industry which have made magnesium available in large quantities and at a low price and have produced alloys, metallurgical processes and fabrication techniques so that this light metal — no longer "rare" — is being used as a vital metal in airplane construction. One of the most important recent advances, of course, has been the development and successful operation on a large scale of a process for making magnesium from ocean water. This assures the United States of a truly unlimited supply of raw materials needed in the winning of this vital metal.

Of special interest is a new method of arc welding magnesium that requires no welding flux and thus eliminates the possibility of corrosion from flux-contaminated metal. This makes the repair of castings and other magnesium products possible and feasible, and opens up entire new fields of airplane design.

Historians will look back at 1942 as an epic year in the transition of magnesium from a relatively obscure material to a well known vital structural metal.

L. B. GRANT
Manager of Production Control
Dowmetal Division
Dow Chemical Co.

Magnesium Fabricated in Mass Production

MAGNESIUM, lightest of the metals that are commercially available for structural purposes, was first produced in America only 25 years ago. Before the present world conflict began, the magnesium industry was still a comparative infant and was operated on what might be called a jobbing basis rather than on production lines. Today, all the engines designed in this country for our combat planes contain magnesium parts of one kind or another. The same is true of the engines in a great many of our training planes. Magnesium, the metal, has suddenly grown up!

Perhaps the best indication of its growing importance in this war can be found in the fact that production of virgin magnesium is now approximately eight times what it was as recently as September, 1939, and the American Magnesium Corp.'s production of fabricated products was more than 16 times as great in July, 1942 as it had been three years before.

Magnesium goes to war in more forms than just engine parts. Aircraft wheels, airframes and accessories practically all utilize growing quantities of magnesium. To produce the quantities of metal needed for the wartime aircraft program of the United Nations, the magnesium industry has shifted rapidly to mass production. Large-scale operations have brought with them the development of new and better tools, plants, and equipment, as well as greater efficiency of production. The magnesium industry is geared for war and will doubtless play an increasingly important part in winning it.

WISER BROWN
First Vice-President & General Manager
American Magnesium Corp.

Tin, Smelted in America

WITH Japanese forces in possession of Indo-China, Thailand, Dutch East Indies, Straits Settlements, Malaya, and Burma, the enemy now holds control of the source of two-thirds of the world's tin supply, and a similar proportion of the smelting capacity. While it is very doubtful if either the mines or the smelters were left in shape to be of much immediate use to the conquerors, at any rate the United Nations have been deprived of that share of their usual supply, and this has struck especially hard on the United States. To offset this shortage, a smelting plant has been built with Government funds, to be operated under lease by one of the Dutch smelting firms, using ore imported from Bolivia. This plant is now in operation, and is being expanded to double or more the capacity originally planned. While import figures have been suppressed, it was officially announced early in 1942 that a sufficient ore supply had been secured to permit operation of the plant at full capacity, while the heavy imports of the past two years have built up a reserve supply sufficient to cover immediate needs. Meanwhile, great efforts are being made by American industry to conserve the metal, as is well known to American metallurgists. Prominent may be mentioned the electroplating instead of hot dipping for making tin plate, and the use of low-tin solders, bearing metals, and bronzes.

GAR A. ROUSH
Editor
The Mineral Industry

A Sour Note: Copper Production Lags

COPPER did not appear in an Ordnance Department report on strategic and critical metals dated March 1940. At that time it was regarded neither as "strategic" (largely imported) or "critical" (a metal for which "some degree of conservation might be necessary"). However, in War Production Board's statement of August 21, 1942, it is classed with nickel and tin as "most critical" — that is "insufficient for *essential* needs", so copper has gone a long way in two years.

The Editor has attempted to get some authoritative statement from producers of the metal and from WPB on the situation, but the former say the censor won't release the figures, and the latter has nothing to say.

It is quoting no secret information to say that Nazi Europe can mine no more than 125,000 tons of copper per year. It is also on the record that Germany used 500,000 tons of new copper in the year 1938, getting ready for the blitz; now that the blitz is on, Germany undoubtedly gets by with the 125,000 tons of new copper mined.

plus what scrap can be stolen from conquered areas. From the standpoint of war-making, then, there must be something wrong with American planners and metallurgists when nearly 2,000,000 tons of copper a year is "insufficient for *essential* needs". One million of this total comes from mine production in the United States; a half-million is imported from South America and Mexico; a third of a million is recovered from demolition scrap.

There is also something wrong with mine and smelter production of new copper.

On Sept. 8 the War Manpower Commissioner (Mr. McNutt) issued orders that "except under certain specified conditions, workers in the non-ferrous metal and lumber industries in the Western States may not switch to other jobs, nor may employers in those industries release workers for other jobs, without first obtaining a certificate of separation from the United States Employment Service." (Method of enforcement and penalties not specified.) Evidence cited by Chairman McNutt in explaining the urgent need for the plan, based on the anti-pirating policy, included the following:

"Copper production fell off 11,000 tons in June and July, mostly for lack of workers. There is a current need for increased production and the present employment should rise substantially in the next few months. In the face of that need, 28 mines employing about 31,000 workers reported for a four-month period ending July 15 that they had hired 5600 workers and lost 6200. For the industry as a whole, a rise in total employment of about 6700 workers is needed by the end of this year. . . . .

"An ordnance plant in Utah, which had attracted workers from the copper industry, was recently forced to reduce its own output due to copper shortages.

"Similar instances have occurred in the zinc and other non-ferrous metal mining industries.

"Aluminum needs are indicated by the situation at one point in Washington, where only one pot line out of three is in operation. The present loss of output due to the two inactive lines is about 200,000 lb. of aluminum a day. Operations at other major points have also been threatened with manpower shortages on several occasions."

That, members of the ⊕, is what is wrong with the copper situation.

ERNEST E. THUM
Editor
Metal Progress

Metals, Men and Machines

EIGHTEEN MONTHS before Pearl Harbor, one of our advertisements was headed: "Revere is ready with the 3 M's for M-Day." It described how Metals, Men and Machines in Revere plants had been systematically prepared for the needs of war production. In stepping up the production of war products still further in the last year, we have devoted our efforts to increasing the effectiveness of the same three M's in a way that can best be typified by a few examples.

Among the alloys most widely used for condenser tubes aboard ship and for other extreme services is cupro-nickel. We have improved the life of cupro-nickel tubes by constantly studying the casting and working of this material. Tube replacements are reduced, scarce metals are conserved, and longer, uninterrupted service is insured. This is one example in *Metals*.

In *Men*, the story is necessarily different. Revere has always fostered the human touch, with the result that our workers have developed the "feel" of brass. When new plants were built or facilities expanded so that additional men had to be trained, green workmen have been quick to pick up an understanding, not only of what they are doing, but *why*, due to this characteristic of the older experienced men among whom they are working.

Many advances have been made in *Machines*. For the speedy handling of heavy coils, not only in moving them from one operation to another, but in controlling their passage through various processes, Revere devised a new conveyor system not unlike a roller coaster in appearance, which moves and routes a continuous procession of coils with the efficiency of a well-run railroad. The result is faster production, more efficient control and — more important — freeing the energies of skilled men, so they can use brains instead of brawn.

These, plus a Technical Advisory Service — a field organization devoted to making the results of our research and development work available to users of our metals — are concrete instances of the three-fold way in which this company is constantly searching out new roads to greater production for victory.

NORMAN A. SCHUELE
Advertising Manager
Revere Copper & Brass, Inc.

Improved Plants, Enhanced Skills

BRASS, BRONZE AND COPPER are most essential for the war effort and the United States Government has first call on the products as well as the manufacturing skills of this company. Although Bridgeport Brass Co. has always been essentially a producer of metals for peaceful uses, nevertheless, the outbreak of World War II found it prepared for emergency. A new $4,500,000 rolling mill with its modern equipment had been completed late in 1938 and the modernization and expansion program of the other mills and the fabricating division were completed in the fall of 1939.

Keeping pace with the times, the company is now 100% in the war program, supplying the Government with essential war materiel and furnishing metal to a multitude of companies which have changed over from civilian to war products. Many of these firms have been aided by the services of our engineering and metallurgical staffs.

With the speeding up of the war program, the installation of additional presses and special equipment soon converted our fabricating division into an ordnance plant. As more and more cartridge brass and war materiel were called for, the company designed and built for the Defense Plant Corp. a large brass mill and fabricating plant in the Middle West. A similar but smaller plant was also constructed for the United States Navy. Both of these new plants are now operating.

On October 24, 1941 Bridgeport Brass Co. was awarded the Navy "E" pennant and the Bureau of Ordnance flag, the first to be awarded in New England. Since then it has received the all-Navy "E" burgee for continued excellence in production.

WILLIAM R. WEBSTER
Chairman of the Board
Bridgeport Brass Co.

High Strength Bronzes From Scrap

APPRECIATING the important position of brass and bronze castings in war production, the entire industry which makes nonferrous ingot metal has exerted every effort to meet its share of the increased demand for alloy ingot used to manufacture these castings. This has involved intensive operations and a high rate of production, sometimes in spite of a relative scarcity of desirable raw material. Specifically, the writer's organization has practically doubled its plant capacity, and production has expanded correspondingly.

We have also cooperated with the various technical societies, specification-writing bodies, and government agencies in helping them to replace alloys requiring virgin copper and tin with others that can be made from ingot manufactured from available scrap and little or no virgin metal. This has released very sizable tonnages of new copper and tin for use where no substitutions at present are available.

A large change has occurred in the composition of the alloy ingot most in demand. It was obvious months ago that there would be a large increase in the consumption of high tensile manganese bronze and aluminum bronze, and our research department intensively studied the production problems. Today we have no trouble in supplying manganese bronzes with a minimum tensile strength of 110,000 psi. (10,000 lb. higher than the former standard) and minimum elongation of 12%. The same relative improvement has been shown in the aluminum bronzes, both as-cast and heat treated. These alloys have taken the place of many copper-tin analyses high in tin and low in lead, and this is in line with the tin conservation program. In fact, our production of manganese and aluminum bronzes has increased from below 5% to practically 25% of our total production.

WILLIAM ROMANOFF
Vice-President & Technical Supt.
H. Kramer & Co.

Bearings and Bushings for the War Effort

FEDERAL-MOGUL Corp. has been particularly fortunate in that the regular products—sleeve type bearings and bushings, bearing metal alloys and marine propellers—are greatly needed in war products and we are able to produce more and more of the parts we have always made and in which we have specialized for the last 45 years.

The first problem therefore has been to

increase production. For the plants we had at the start of war production, many new and highly specialized machine tools were obtained, and all departments were rearranged to permit their proper installation. An immediate study was made as to the most efficient number of hours to work. This was found to be six days at 24 hr. per day and one 8-hr. shift on Sunday. The balance of Sunday is utilized to keep all machines in perfect condition.

Following this, new plants were built or purchased. So far there have been five of these, with another in immediate prospect.

It may be interesting to note that our shipments for *one day* recently about equalled our total shipments for six months just preceding the last world war. Shipments are now running at a rate 2½ times as great as they were in 1940.

It is constantly necessary for us to recommend substitute materials in our sincere effort to conserve vital metals such as tin, copper, cadmium and steel, so they may be used where they are actually required. This, we believe, is very important.

About every month a meeting of the Manufacturing Department Supervisors is held at night in which our Factory Manager reviews the accomplishments of each department since the previous meeting and points out plans for further increase. These meetings have clearly demonstrated their worth by actual results. Quality of workmanship is preached incessantly so that loss is reduced to a figure scarcely even hoped for a year or so ago. This means more parts shipped and more material conserved.

E. Olney Jones
Sales Manager
Federal-Mogul Corp.

Contacts—Joints—Silver Makes Them

SILVER is proving to be a vital metal in speeding war production. Thought of for years by most people as a luxury metal, it has today put on overalls and gone to work in a surprising number of places.

Fine silver is doing a number of important jobs. One of the most vital is its use as a lining for engine bearings on our latest airplanes. Plated on the steel bearing it gives extra strength to withstand higher bearing pressures and stands up better under high operating temperatures of these powerful motors. In the plating field, fine silver has also done a good job of replacing copper, nickel, chromium and cadmium, permitting their use for more important purposes. As an electrical contact metal fine silver and silver alloys are being used in tremendous quantities on ships, airplanes, tanks and in essential industries, and for this purpose silver has no peer.

But by far the greatest industrial use of silver metal is in the form of brazing alloys used on thousands of metal-joining jobs in the making of ships, tanks, guns, airplanes, shells and other ordnance materiel.

On transport, cargo and fighting ships mile after mile of piping is joined permanently with "Sil-Fos" brazing alloys. These piping systems include services such as hot and cold water lines, salt water lines, steam heating lines, oil and fuel lines, waste and drain lines, and piping for refrigerant and vacuum systems. Pipe assemblies of this kind speed up the work. One instance showed a saving of three months in completing a piping contract on one vessel. Brazing permits the use of thinner walled piping due to the absence of threads; metal is saved and dead weight reduced.

In airplane work, two outstanding jobs are the silver alloy brazed ignition radio shield, and the brazing of radiators for P-39's and P-40's. The number of miscellaneous jobs is large, and includes propellers, spark plugs, carburetor parts, air scoops, breather pipes, fuel and oil lines, electrical connections, oil coolers, instrument and instrument connections and de-icers. Even parachute rip-cord grips are brazed with silver brazing alloy.

Adapters, burster casings, fuse seat liners, filler plugs and bases are being joined together with silver alloy, in enormous numbers of bombs and shells.

Likewise in gun and machine gun production important parts in the cooling systems and firing mechanism look to silver alloys for fast production and reliable joints.

Among the miscellaneous equipment where silver brazing alloys are helping to speed up work, you'll find such units as Army field stoves, coffee urns for the Navy, filler cap connections on water containers for tanks, switch housings

and light sockets for aircraft and marine uses — the list is nearly endless.

These production jobs indicate how widely silver and its alloys are being used and that silver has, in a short space of time, become an important metal to industry as well as to the fine arts.

ROBERT H. LEACH
Vice-President
Handy & Harman

Surplus Lead to Stockpile

DURING the last 12 months the lead industry has made great efforts to increase the output. In the fourth quarter of 1941 several of the large mines stepped up their weekly operations from five to six or six and a half days per week. After the turn of the year, when the two-price system was introduced, whereby the mines were assigned quotas and urged to exceed them, the price of lead for production up to the quotas was advanced to 6.50¢ per lb. New York, and the price for over-quota production was made 9.25¢. Then a good many small mines were put into operation; in other places old tailings piles were re-treated by mills. Considerable lead consequently originated from mines or other properties which had been shut down. At the present time however, the labor supply, particularly in the Rocky Mountain districts, has been inadequate to produce as much metal as the rated output of these districts would indicate.

But in this day when metals generally are scarce, it is a relief to find lead in abundant supply. To safeguard the situation W.P.B. has banned unessential uses and has restricted the consumption of other lead products going into civilian supply. Domestic production plus imports have consequently made available a tonnage which enabled the Government to stockpile a sizable quantity of refined lead. Probably at this time the total United States monthly consumption is less than 65% of the new lead produced and imported each month.

In order to capitalize on this situation and to help the war effort, industry should endeavor to replace more strategic metals with pig lead. Some substitutions have already been made. For instance, the lead content of solder has been increased to replace some tin; sheet lead hardened with antimony is taking the place of some zinc sheets; lead-coated steel sheets and lead pipe have been used in place of galvanized iron. Paints, in which the lead pigment has been restricted, should again be permitted to contain higher percentages of lead carbonate and lead oxide. There are many other places where either pure lead or antimonial lead might take the place of other commodities.

IRWIN H. CORNELL
Vice-President
St. Joseph Lead Co.

Increased Production of Lead Products

LIKE MANY other large manufacturers, National Lead Co. has made every effort to increase the output of products required for war activities and has adapted existing equipment for the making of new war products, and for the essential needs of other industries serving the armed forces. It has also tried in every way to increase operating efficiency and conserve critical materials in the manufacture of the required products for civilian use. Increased output of war products has been attained by maximum use of all available manufacturing equipment, in many cases operating machinery 24 hr. a day which previously had been used during only one or two shifts. Heavy and light metal presses have been converted to the manufacture of war products to a very large extent. The production of pigments, lead oxides and other chemical materials has also been increased to supply the rapidly expanding demand.

National Lead Co. has long manufactured lead and lead alloy products, many of which are required in the construction of Navy and Maritime ships, guns, combat vehicles and other equipment. Such products include lead and antimonial lead sheet and pipe, bearing metals, solder and other alloys. In stepping up this production for the armed forces every effort has been made to conform to the highest specifications where they apply, but at the same time we have taken a considerable part in developing adequate alternates which conserve scarce materials for many uses.

R. L. HALLETT
Chief Chemist
National Lead Co.

ALUMINUM ALLOYS

Compositions, Properties, and Designations of American Commercial Alloys

Compiled by H. S. Jerabek, University of Minnesota, from Handbooks and Specifications of American Society for Metals, American Society for Testing Materials, Society of Automotive Engineers, & Aluminum Co. of America

Wrought Alloys

Designations: S.A.E. No.	Designations: A.S.T.M. Specification	Designations: Alcoa No.(a)	Composition (Aluminum = Balance): Cu	Si	Mn	Mg		Form Tested	Tensile(b) Strength, 1000 Psi.: Ave.	Min.	Yield(b) Strength, 1000 Psi.: Ave.	Min.	Elong., % in 2 In.: Ave.	Min.	Brinell Hardness	Shear Str.(b) 1000 Psi.	Endur. Limit(c) 1000 Psi.	Cold Bend Test(d)	Corrosion Resistance in NaCl(e)	Alcoa No.	Characteristics and Uses
									Work Hardening Alloys(f)												
25	B25-41T	2s O					99 Al	1/16" Sheet	13	(15.5 max.)	5		35	30	23	9.5	5	A	B	2s O	Commercial Al; Good Forming Properties
	B25-41T	2s ½H						" "	17	16	14		9	7	32	11		B	B	2s ½H	Good Corrosion Resistance, Low Yield Str.
	B25-41T	2s H						" "	24	22	21		5	4	44	13	8.5	F	B	2s H	Cooking Utensils, Sheet and Tubing
29	B79-41T	3s O			1.2			" "	16	(19 max.)	5		30	25	28	11	6	A	B	3s O	Similar to 25
	B79-41T	3s ½H						" "	21	19.5	18		8	6	40	14	9	C	B	3s ½H	Slightly Stronger and Less Ductile
	B79-41T	3s H						" "	29	27	25		4	4	55	16	10	G	B	3s H	Cooking Utensils, Sheet Metal Work
201	B109-41T	52s O				2.5	Cr 0.25	" "	29	(31 max.)	14		25	20	45	18	17	A	B	52s O	Strongest Work Hardening Alloy
	B109-41T	52s ½H						" "	37	34	29		10	7	67	21	19	D	B	52s ½H	High Yield Strength and Fatigue Limit
	B109-41T	52s H						" "	41	39	36		7	4	85	24	20.5	G	B	52s H	Highly Stressed Sheet Metal Products
									Precipitation Hardening Alloys(g)												
26	B78-41T	17s O	4		0.5	0.5		" "	26	(35 max.)	10		20	12	45	18	11	B	E	17s O	Duralumin. Most Common Strong Alloy
	B78-41T	17s T						" "	60	55	37	32	20	18	100	38	15	H	D	17s T	Hardened by Quenching and Aging
	B78-41T	17s RT						" "	65	55	47	42	13	12	110	38		J		17s RT	Available in Most Wrought Forms
		Alclad 17s T	(Coated with 99.75+Al)					" "	56	50	33	28	18	16		32		I	A	Alclad 17s T	Alclad Has Best Corrosion Resistance
		17s T						Forging	55	50	30	30	16	16	100	36	15		D	17s T	High Strength Heat Treated Forgings
		A 17s	2.5			0.3		½" Rod	43		24		24		70	26	13.5	F	D	A 17s	Best Forming Properties. Rivets
24		24s O	4.6		0.6	1.5		1/16" Sheet	26	(35 max.)	10		20	12	42	18	12	B	E	24s O	Strongest Alloy for Rolled Forms
		24s T						" "	68	62	44	40	19	17	105	41	18	J	D	24s T	Used Widely in Aircraft Construction
		24s RT						" "	70	65	55	50	13	12	116	42		K	D	24s RT	More Difficult to Form Than 17s
		Alclad 24s T	(Coated with 99.75+Al)					" "	62	56	41	37	18	16		40		J	A	Alclad 24s T	High Strength Alclad; Corr. Resistance
		61s W	0.25	0.55		1.0	Cr 0.25	" "	35		21		22		65	24	12.5	F	C	61s W	Good Forming Properties, High Yield Str.
		61s T						" "	45		39		12		95	30	12.5	G	C	61s T	Will Not Age Harden at Room Temp.
		53s W		0.7		1.3	Cr 0.25	" "	33	28	20	16	22	17	65	20	10	F	B	53s W	Good Forming Properties and
		53s T						" "	39	35	33	28	14	10	80	24	11	G	B	53s T	Corrosion Resistance
280		A51s T		1.0		0.6	Cr 0.25	Forging	44		34		14		90	32	10.5		C	A51s T	For Intricate Forgings
27		25s T	4.5	0.8	0.8			"	55		30		16		100	35	15		E	25s T	Good Forgeability. Lower Cost.
		14s T	4.4	0.8	0.8	0.4		"	65		50		10		130	45	16		D	14s T	Strongest Forging Alloy
		70s T	1.0		0.7	0.4	Zn 10	"	50		40		16		85	37	19		F	70s T	High Endurance Limit
		18s T	4			0.5	Ni 2	"	55		35		10		100	35			E	18s T	Strong at Elevated Temp.; Forged Pistons
		32s T	0.8	12		1.0	Ni 0.8	"	52		40		5		115	38	14		C	32s T	Forged Aircraft Pistons. "Low-X"
		11s T3	5.5			(Bi 0.5)	Pb 0.5	½" Rod	49		42		14		100	30	12.5		E	11s T3	Free-Cutting Screw Machine Products

Sand Casting Alloys

S.A.E.	A.S.T.M. B26-41T	Alcoa	Cu	Si	Fe	Mg	Zn	Condition	T.S.(b)		Y.S.(b)	Elongation		BHN	Shear	Endur.(c)	Impact	Corr.(e)	Alcoa	
33	CC	212	8	1.2	1			As Cast	22	19	14	2	0	50 to 70	20	7.5	0.6	D	212	General Casting Alloy. Not Heat Treated
38	C	112	7.5		1.2		1.5	" "	22	19	14	1.5	0	55 to 80	20	8	0.6	D	112	Good Casting Properties
31		645	2.8	1.2			11	" "	29	25	22	4	2.5	70	22.5	7.5	1	D	645	General Casting Alloy
35	JJ	43		5				" "	19	17	9	6	3	55 to 50	14	6.5	1	A	43	Thin, Pressure Tight Castings. Corr. Res.
37	K	47		12.5	(Trace Na)			Modified	26	24	11	8	5	45 to 60	18	6	3	A	47	Alpax or Silumin. High Strength, Elong.
38	G HT1	195 T4	4					Soln. H.T.	31	29	16	8	6	55 to 75	24	6	2.8	C	195 T4	High Strength Heat Treated Castings
38	G HT2	195 T6	4					H.T.	36	32	22	4	3	70 to 90	30	6.5	1.8		195 T6	Aircraft, Marine, Bus,
38	G HT3	195 T62	4					H.T.	40	36	31	2	0	80 to 100	31	7	1.3		195 T62	and Engine Parts
		A 334	3	4		0.3		As Cast	26	22	20	1.5	0	65	24		0.7	B	A 334	Intricate Castings
322-1	N HT1	355 T4	1.2	5		0.5		Soln. H.T.	30	26.5	20	5	3.5	50 to 65	28		1.3	A	355 T4	Liquid Cooled Cylinder Heads
322-2	N HT2	355 T6						H.T.	35	32	25	3.5	2	65 to 85	30		1.1		355 T6	Intricate Castings
322-3		355 T61						H.T.	38	35	33	1	0.5	80 to 95			0.8		355 T61	Good High Temperature Strength
	N HT3	355 T51						H.T.	28	25	23	1.5	0	50 to 70	22	6.5			355 T51	Water Jackets, Exhaust Manifolds
	M HT1	356 T4		7		0.3		Soln. H.T.	28	26	18	6	5	50 to 70	18		1.7	A	356 T4	Intricate Heat Treated Castings
	M HT2	356 T6						H.T.	32	30	22	4	3	60 to 80	22	8	1.0		356 T6	Good Corr. Resistance, Pressure Tightness
320	L	214				3.75		As Cast	25	22	12	9	6	40 to 60	19	5.5	3.8	A	214	" " " , Impact Toughness
324		220 T4				10		Soln. H.T.	44	42	25	14	12	70 to 85	33	7	4.5	A	220 T4	Highest Impact Toughness(h)
	F	122	10		1.2	0.2		As Cast		18.5			0					D	122	Common Piston Alloy. Wear Resistance
	F	122 T2						Soln. H.T.	25	23	21	1	0	75	25.5	9.5	0.7	D	122 T2	High Temperature Strength
	F	122 T61						H.T.	36	30	30	1	0	100	29.5		0.68	D	122 T61	Also Permanent Mold Castings
39	H	142	4			1.5	(Ni 2)	As Cast	28	23	24	1	0	85	24	8	0.6	C	142	High Temperature Strength and Stability
39	H	142 T61						H.T.	37	32	32	0.5	0	100	32	8		C	142 T61	Also Permanent Mold Castings

(a) Aluminum Co. of America Alloy No. & Heat Treatment Designations: O-Annealed, W-As Quenched, T-Quenched & Aged, H-Cold Rolled to Hard Temper, ½H-Half Hard Temper, R-Cold Rolled After Heat Treatment, S-Wrought Alloy.

(b) In Thousands of Pounds per Square Inch. Yield Strength Taken at 0.2% Permanent Set.

(c) 500 Million Cycles in Reverse Bending.

(d) Relative Forming Properties in Cold Bending; A-Best

(e) Relative Resistance to Salt Water Corrosion; A-Best

(f) Can Be Hardened by Cold Work Only.

(g) " " " " Heat Treatment.

(h) Special Foundry Practice Required.

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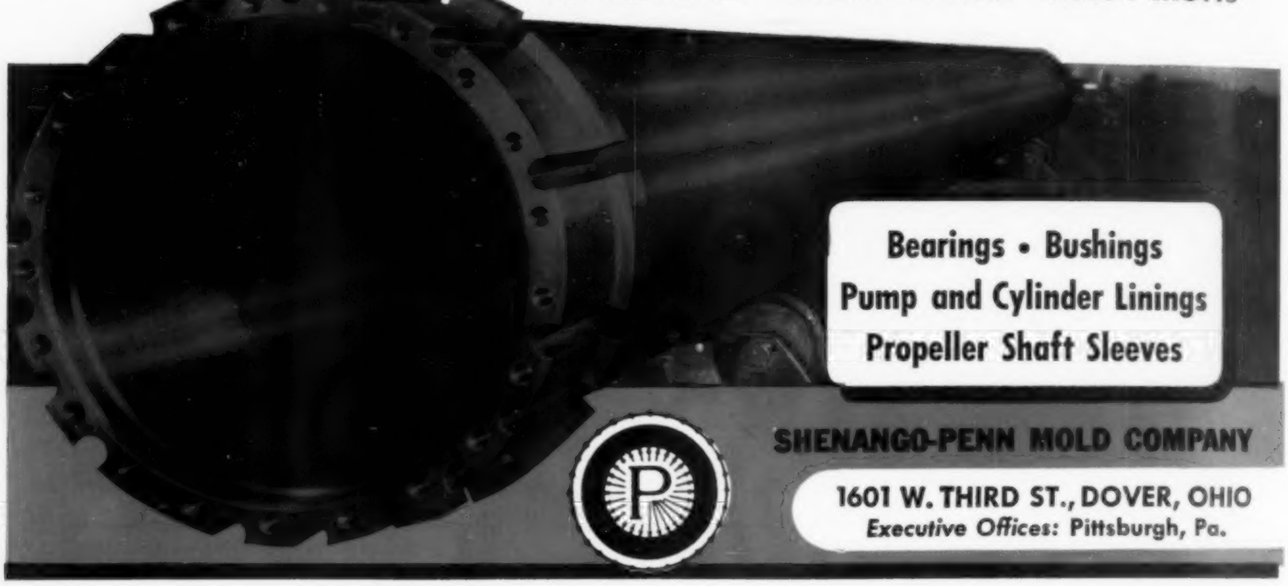

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FOR ALL PURPOSES

OFHC Copper conforms to the A.S.T.M. Specification for electrolytic copper wirebars, cakes, etc., B5-27 with regard to metal content and resistivity, and is free from cuprous oxide.

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THE PROPERTIES OF LEAD

Chemical Corrosion Resistance

The high resistance of lead to the corrosive action of chemicals, particularly those commonly used—such as sulphuric acid—has led to its adoption as the standard material for equipment used in the manufacture, handling and transporting of chemicals. Generally, Chemical Lead is used, but if greater strength and rigidity are needed, antimonial lead may be employed. In some few cases, as in handling sodium chloride solution or hydrochloric acid, antimonial lead is more resistant to corrosion than soft lead.

RATE OF CORROSION

Chemical	Temp. °C	Loss in Weight in Grams /M²/100 Hours			
		Lead (Common)	Lead (99.99+%)	Common Lead (+.06 Copper)	Electro. Lead (+.10 Copper)
70% H_2SO_4	170°	7000	4600	1000	500
70% H_2SO_4	130°	1110	700	350	300
70% H_2SO_4	90°	38	19	11	9
70% H_2SO_4	20°	11	4	4	4
20% HCL	90°	230	100	300	310
20% HCL	20°	160	50	290	280
10% HCL	20°	28	16	55	45

In another series of tests in 10% sulphuric acid at 98° C for a period of 5 weeks, various elements were added to Chemical Lead (.06% Cu) to determine whether such additions improved the corrosion resistance.

	Loss in Grams Per 100 sq. cms.
Chemical Lead + .56 Sb, .27 Cd	1.25
Chemical Lead + .56 Sb	1.22
Chemical Lead + .10 Ca	.93
Chemical Lead + .026 Ca	.77
Chemical Lead + .02 Ni	.71
Chemical Lead — no addition	.66

A rise in temperature increases the rate of corrosion. In this test, lead containing .06 Cu was used.

Temperature °C	20°	60°	100°
	Loss in Grams Per 100 sq. Cms.		
35% H_2SO_4	.11	.22	.42
75% H_2SO_4	.12	.34	.60

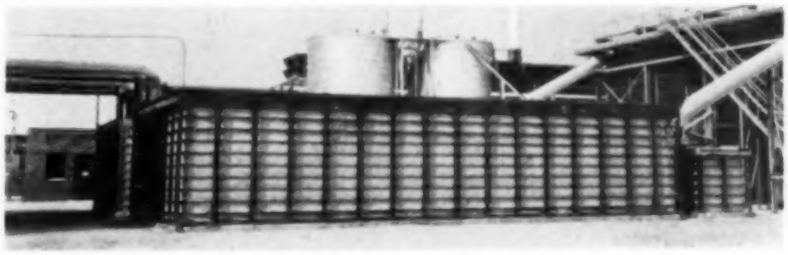
Among the metals commonly used in contact with salt water, only two, both of which are more costly, surpass lead in resistance to this type of corrosion. The following table shows the results of salt water corrosion on pure lead. In this case the samples were exposed to salt water solution of varying strength for a period of 200 days. The temperature of the solution was 8.5°C.

NaCl Concentration in per cent	0	.25	.50	.75	1	1.5	3	6
Loss in Weight in per cent	.0334	.2331	.2626	.4003	.6982	.567	.243	.127
Corrosion Factor	100	697	786	1198	2090	1696	726	364

It is of interest to note that the rate of corrosion increases up to 1% and thereafter decreases, a loss in weight of approximately .25% occurring at 2.7% which is the salt concentration of sea water.

The most outstanding use of lead because of its chemical corrosion resistance, is in the manufacture and handling of sulphuric acid.

•



All-lead chambers in Sulphuric Acid System, with lead piping leading in and out each end.

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THE LARGEST PRODUCER OF LEAD IN THE UNITED STATES

ALUMINUM BRONZES COMMONLY USED IN AIRCRAFT

Compiled by W. W. Edens, Ampco Metal Inc.

Nominal Composition	Form or Condition	Specification Met (2)	Tensile Strength, Psi.	Yield Strength, (0.5% Elon.), Psi.	Proportional Limit, Psi (Min.)	Elon. in 2 In., %	Reduction of Area, %	Brinell Hardness, (3000 kg)	Rockwell Hardness	Elastic Limit in Compression, Psi.	Impact (Min.) Izod, Ft-Lb.	Impact (Min.) Charpy, Ft-Lb.	Metallographic Structure	Representative Uses in Aircraft
90% Cu 9% Al 1% Fe	Rods, Bars, Forgings	AMS-4630 A	72-80,000	33-40,000	20,000	15-25	15-25	130-170	72-83B	30,000			Primary α, Small Am't & Eutectic	Motor Parts, Bearing Liners, Thrust Pads, Retainer Plates, Bushings, Guides, Gears
	Rods, Bars	AMS-4632	72-80,000	40-50,000	25,000	5-15	5-15	175-200	88-94B	40,000			Primary α, Many Twinned Crystals Due to Cold Work	Misc Guides, Gears, Bushings
	Cast and Heat Treated	QQB-671a Class B	80-88,000	40-45,000	22,000	12-20	12-20	140-163	84-92B	35,000	25	17	Primary and Re-precipitated α in Beta Matrix	Gun Mountings, Trunnion Yokes, Gears, Bushings, Landing Gear Nuts
	*													
88.6% Cu 8.6% Al 2.8% Fe	Sand Cast	QQB-671a "A" 46B-18c SAE-68	65-75,000	28-34,000	14,000	22-30	22-30	116-130	65-72B	18,000	75	60	Primary Alpha	Misc. Bushings, Bearings, Slides & Mountings
	Centrifugal Cast	QQB-671a "A" 46B-18c SAE-68	75-85,000	29-35,000	15,000	28-36	28-36	120-140	66-73B	18,500	75	60	Primary α in Small Am't of Beta Matrix	Same as Sand Cast But Preferred Where Type of Casting Permits
	*													
87.0% Cu 9.8% Al 3.2% Fe	Bars, Rods, Forgings (1)	QQB-666 "B" 46B-17	72-95,000	35-55,000		15-25	15-25	140-200	84-94B	40,000			Primary α With Beta & Eut. Matrix	Landing Gear Bushings, Nuts and Other Parts. Windshield and Defroster Parts
	Centrifugal Cast	QQB-666 "B" 46B-17 (On Approval)	80-90,000	30-40,000	15,000	20-27	20-27	131-159	73-83B	25,000	40	30	Primary α in Beta & Eutectic Matrix	Substituted for Wrought Material in Larger Sized Work Where Bushing Stock Conserves Time & Waste of Material
	*													
85.6% Cu 10.8% Al 3.6% Fe	Sand Cast	QQB-671a "C"	77-85,000	35-42,000	18,000	12-20	12-20	159-183	83-90B	30,000	25	17	Primary α in Beta & Eutectic Matrix	Wear Plates, Hinge Plates, Pump Bodies, Gears, Bushings
	Centrifugal Cast	QQB-671a "C" PWA-241	90-100,000	38-45,000	19,000	6-12	6-12	179-207	88-94B	32,000	28	19	Primary α in Beta & Eutectic Matrix	Propeller Blade Bushings, Pump Parts, Bearings, Bushings, Gears
	Cast and Heat Treated	QQB-671a "D"	90-100,000	45-50,000	30,000	10-15	10-15	179-207	88-94B	45,000	20	14	Reprecipitated α in Beta Matrix	Propeller Parts, Propeller Hub Nuts, Landing Gear Parts, Misc. Bushings & Bearings
	Cast and Heat Treated	AN-QQB-672 (Air Corps 11076)	85-95,000	47-54,000	33,000	3-7	3-7	202-235	93-99B	50,000	18	11	Reprecipitated α in Beta Matrix	Propeller Rear Cones, Landing Gear Parts, Valve Seats, Tail Wheel Parts
	*													
81.2% Cu 10.8% Al 4.0% Ni 4.0% Fe	Rods, Bars Heat Treated	AMS-4640	90-100,000	45-50,000	35,000	5-10	5-10	202-235	93-99B	50,000	18	11	Alpha in Beta & Eutectic Matrix	Misc. Bushings & Bearings, Guides, Valve Seats
	Cast and Heat Treated	AN-QQB-672 (Air Corps 11076)	90-100,000	45-50,000	33,000	5-10	5-10	202-235	93-99B	50,000	18	11	Reprecipitated & Some Primary α in Beta Matrix	Landing Gear Parts, Propeller Locking Nuts, Valve Seats
	*													
81.3% Cu 14.0% Al 4.7% Fe	Centrifugal Cast	HSP-22	80-90,000	45,000 Min.		1-3	1-3	311-350	34-38C	65,000	9	4	Delta Crystals in Beta & Eut. Matrix	Propeller Cam Rollers, Drawing & Forming Dies for Carbon & Stainless Steels & Aluminum
	*													

(1) Properties Vary With Diameter & Anneal.
(2) Ranges of Properties Are Commercial Ranges Available Although in Many Cases Low Figure of Range is Specification Minimum.
* Spaces Left Open for Chart Users to Add Specialized Alloys of Similar Composition With Properties Varied by Heat Treatment or Cold Work to Meet Unusual Application.
Note—Modulus of Elasticity is Approx. 15,000,000 for All Alloys. Weight per Cubic Inch is Approx. 0.27 Lb for All Alloys. Coefficient of Expansion is 0.000009 in. per in. per °F for All Alloys.

Instruments

Economical Instrumentation Helps Everybody

AN INCREASE in instrumentation of industrial processes does in itself increase production. Furthermore whatever momentum is gained by a manufacturer of instruments for industry, that momentum is multiplied many times in its final effect on national production. Not only quantity, but the quality of production is greatly affected. Our company, of course, is no exception to the multitude of manufacturers struggling with the complex problems accompanying expansion. In some departments production has increased many times and all departments have at least doubled their normal figures. Training of new employees, the holding of instruction classes and many other personnel problems require solution. Procurement of materials, particularly of substituted materials, is obviously a most pressing problem.

It may be repeated again that industry should not ask manufacturers to produce special instruments having novel accessories or new designs merely to satisfy a desire when a cataloged instrument would do the job that necessity requires. Economical instrumentation in the metals industries brings up one particular point which is fairly important: We can produce and supply two 6-point indicating controllers and a 12-point recorder more quickly than 12 single-point recorder-controllers and at much less cost. There are some cases, of course, where it is essential to have a recorder at each producing unit, but in many applications this grouping of controls would be quite acceptable. This example illustrates that real and urgent economies can be practiced in the selection of instruments from the many kinds and types that are on the market. Such practice will release engineers to concentrate their efforts on the urgent current problems which the emergency creates.

C. O. FAIRCHILD
Director of Research
C. J. Tagliabue Mfg. Co.

Better Instrumentation by Educating Maker and User

PLANT EXPANSION, dissemination of technical information helpful to manufacturers of war products who use temperature controllers, and moves to improve employee efficiency and morale are combining at Wheelco Instruments Co. to further America's war program.

Over a year ago, manufacturing and management operations were combined in a single building having more than six times the floor area of the old quarters. The change permitted the expansion of production personnel to several times the figure of a year ago, and made available additional space for engineering and research facilities.

In line with the policy of making available all possible information helpful to industrial instrument users in obtaining maximum performance and life of their equipment, the first step was taken in the early days of our then "defense program" with publication of the first Wheelco Thermocouple Data Book. This is really a manual or small textbook on the construction of thermocouples, and methods of checking thermocouples and pyrometers, and the designs and materials suitable for various applications. Another piece of literature aids users of pyrometers, regardless of make, to maintain equipment so it operates efficiently and uninterruptedly. It suggests substitutes for the more critical materials, and compares the properties of the original and the substitute.

Early this year the company established a school for plant and office employees designed to aid them gain a greater knowledge of instruments, their construction and their use by America's war industries. Our employees, like workers in other plants making products used by industry, seldom see the results of their labor in actual use. We believe a clear understanding of how instruments save time and labor, lower costs, and provide exact control of processes directly manufacturing war goods, stimulates

employee interest in the vital part they, as individual workmen, making instruments, are playing in our war.

Likewise, our accumulated experience and enlarged manufacturing facilities have lately permitted the plant to enter promptly into the construction of highly specialized instruments, not closely allied to our peacetime output, for the armed services.

L. W. Wheeler
President
Wheelco Instruments Co.

Standardized Testing Machines
made by mass production methods

HOW is our firm and industry promoting the objective of "Greater Production of War Products"?

In the first place, physical testing facilities are necessary for every manufacturing plant which is supplying the Government because purchases are made on specifications, and testing is required to determine acceptance or rejection in conformance with these specifications. This means that many people who never thought of using a testing machine are now pushing for delivery of one of them.

Baldwin Southwark has met this situation by setting up standard models of machines and trying by every means to persuade purchasers to avoid special features or special dimensions. What this means to mass production can readily be visualized. Our number of standard models is comparatively few — there are, to be exact, seven standard models of universal testing machines instead of the hundred varieties formerly offered on a custom-built basis. Parts for these machines are ordered in large lots and construction is carried through on a production line basis, filling a large section of the shop. The reason deliveries are not made immediately from stock when orders are received is because, no matter how fast our stock lots come through the assembly line, we find that orders are always ahead of them. Consequently, we cannot attain our desired goal of making immediate shipments.

I believe this is a first instance where an entire testing machine manufacturing business has concentrated on standardizing types on a production line basis with the goal of shipping at least one machine per day in the larger sizes. Our recorder and weighing system plants are on a similar high volume production basis. This is a phenomenon which probably will never be seen again.

Francis G. Tatnall
Manager, Testing Machine Dept.
Baldwin Southwark Division
The Baldwin Locomotive Works

Million-Volt X-Ray Unit
speeds heavy production

VASTLY INCREASED DEMANDS for war material confronted American industry with a paradoxical situation. It was imperative that the finished product be of the highest quality. Yet high quality imposed rigid inspection requirements that would normally add hours and even days to inspection time and, as a result, production would be correspondingly restricted.

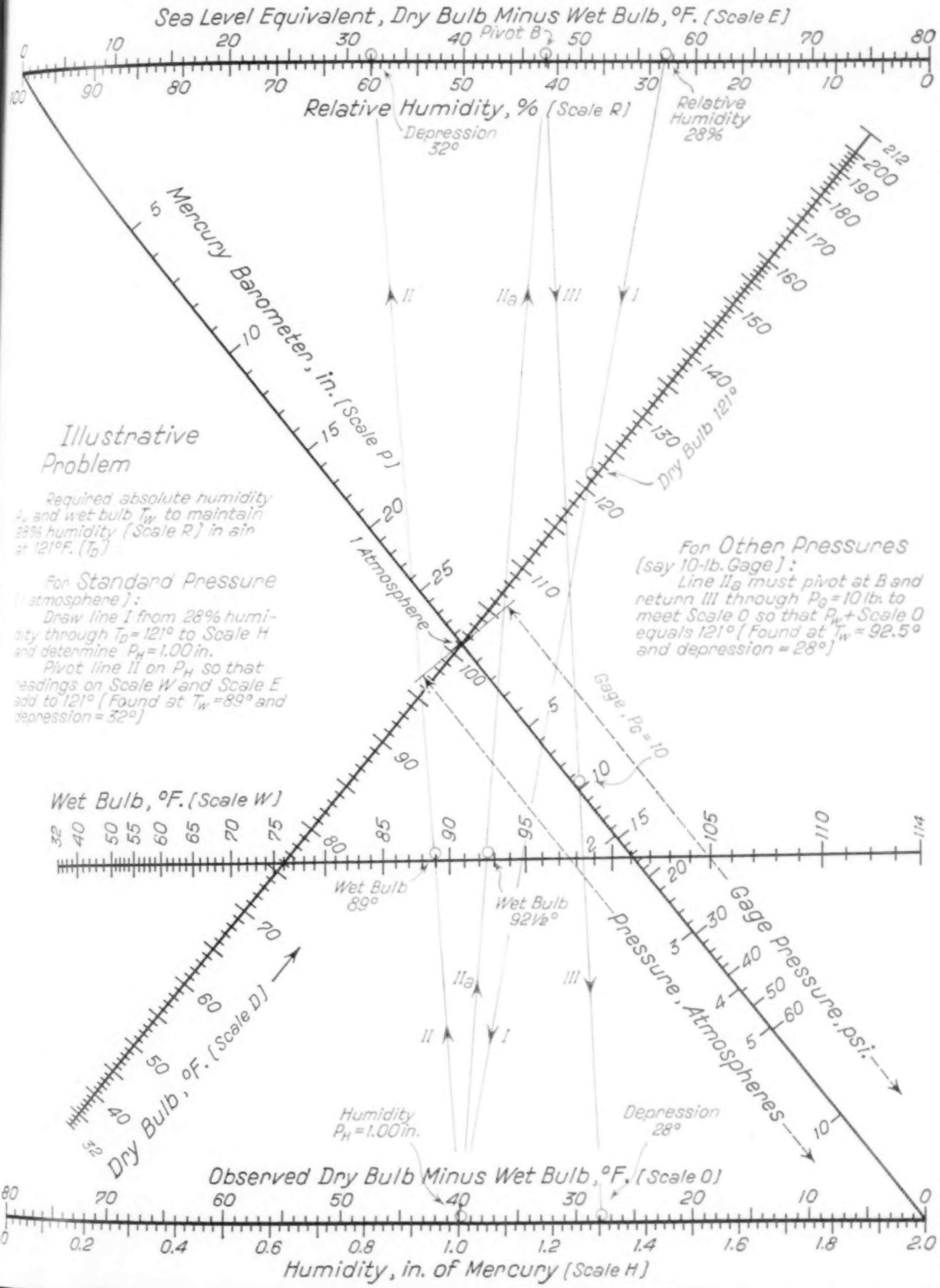
Recent development by the General Electric X-Ray Corp. of a portable million-volt industrial X-ray unit provided a full answer to this difficult problem. With the million-volt X-ray unit, American plants have an inspection tool that is compact and safe, and enables them to insure quality and materially speed up production of very heavy metal objects.

There are many case histories that could be cited as specific evidence of how this unit is helping American industry serve the country more effectively in this emergency. For example, in one of the nation's largest foundries, gun mount production was seriously delayed because inspection couldn't keep up with production. Addition of a million-volt unit speeded up inspection so much that the plant's production could be boosted 10 times above its original schedule.

In a well-known boiler plant, use of the powerful new unit reduced inspection time for heavy boiler drums from 1127 hr. to 31½ hr. Welded seam inspections that used to require 7½ hr. are now done in 8 min.! In another plant, the examination of cast steel crankshafts used to require six times more man-hours per cast-

Psychrometric Chart, High Range

By Donald B. Brooks; National Bureau of Standards. Publication M-146



ing than the technique which is now employed with the million-volt X-ray unit. Consequently this unit has been hailed as "one of the most important advances in the X-ray art". To us, its chief importance is the fact that it is playing a vital role of reducing rejects, insuring high quality and increasing production of the nation's war products.

Other major developments of industrial X-ray inspection apparatus include an automatic unit for rapid production-line examination of castings or metal assemblies; a bearing jig for multiple X-ray examination of cylindrical aircraft, automotive, and diesel engine bearings; and a new, compact, self-contained G-E Photo-Radiograph Unit which will inspect small castings for major defects faster and more economically than direct X-ray methods.

W. S. Kendrick
Vice-President
General Electric X-Ray Corp.

Put the Older Instruments Back to Work

WAR has placed a heavy load on instrument companies, and this load will affect all users of pyrometers, gages, thermometers, electrical instruments, and in fact all types of control apparatus.

Almost all instrument companies in America grew from and were adapted to peacetime needs, based essentially upon the industrial enterprises of this country. The big majority of their output went to such places as steel plants, chemical plants, oil refineries, public utilities, heat treating shops, food processing plants, and similar industrial processes. In contradistinction, the number of instruments the Government or the armed services purchased was almost negligible.

With the coming of first defense effort and then the actual war conditions, the instrument companies have been forced to pile on top of their regular normal industrial business a terrifically increased demand from two sources: First, the increase in industrial activity of both private industry and government-owned war plants, and second, the demands of the armed service for combat instruments.

Consequently, there is hardly an instrument manufacturer in the country who does not have business on his books far in excess of normal capacity. Our ability to fabricate instruments has developed rapidly, but the increased scarcity of materials is bringing the situation to a balance where production is limited by the allocation of materials for them.

Many arguments have been advanced as to whether or not the relatively small amount of critical materials required for instruments should not be put rapidly into more instruments, which in turn would save other critical materials and increase the productive capacity of the country. Without a doubt many of these arguments are true, but it is also equally true that today the only sure way to obtain necessary raw materials is for the instrument companies to accept no orders with insufficient priority standing to secure an allocation of material.

Existing stocks have helped to tide over, but these are nearly exhausted. If the American instrument manufacturer is to provide the number of instruments ordered for combat purposes, production for the industrial group will have to be cut to a minimum. This is not a pleasant situation for any instrument manufacturer nor for his good industrial customers, but it is part of the price of being at war.

Most instrument companies are doing their best to take care of their industrial customers in the essential industries. Since they have worked for years to develop these markets for instruments, naturally they hate to give them up, but in line with placing first things first, certain combat devices must receive priority. Even now there is definitely a shortage of instruments. It is going to increase. Owners of instruments can help by using them to the fullest, and repairing or remodeling the older types. There are many instruments on the shelves of laboratories which can be put into practical use after cleaning, rechecking and minor repairs. Every addition to the working stock in this manner allows the instrument manufacturer to assign that much more productive labor to the direct war effort and saves that much more material.

Instrument companies normally like to sell their latest equipment both for their reputation's sake and from a business point of view, but if we are to win this war sacrifices have got to be made by all and the best productive use of available instruments does help.

This temporary condition is not without compensation, as through the development of new instruments for combat work, certain new industrial developments are bound to follow. We cannot take full advantage of these developments under present conditions, but the instrument business and the instruments users will ultimately have the benefit, and will also have advanced in knowledge and practice.

This is a scientific war and instruments, being guide posts to most scientific processes, naturally are in demand. Manufacturers are hard pressed to fill this demand. By working together the industrial user and maker can both help win the war by freeing as much manufacturing capacity for combat work as possible, and this is best done by using to the fullest all instruments that now exist and by keeping new specifications as simple as possible to meet the real needs.

L. G. Bean
Vice-President
The Bristol Company

Better Equipment Despite Shortages

IN CONTRAST to many lines of endeavor, the war has affected only the amount but not the nature of the work of the Buehler organization; the products are still cutters, grinders, presses, polishers, and other items for the metallurgical laboratory. We have, of course, discontinued some luxury and unnecessary items in the interest of increased capacity in essential apparatus. There have also been changes made in most of the equipment, some of which were forced by circumstances and some by design, to improve our machines for you who make the weapons.

Shortages of men and material, however, have not resulted in inferior machinery. Every problem along this line has been answered by an equal or better machine made some other way or of some other material.

In contrast to the similarity between our past and present production, sales and service efforts have been greatly changed. More personal contacts with the trade have resulted in advice and help with the selection of equipment for new plants, and plants which formerly had no laboratory or trained metallurgists.

While production figures must be withheld, ours are good, but they'll be better. We know they'll have to be to fill the need of those who have the all-important job of turning out the war materiel to win this war.

George W. Graves
Metallurgist & Sales Manager
Adolph I. Buehler

Fast Analytical Returns Speed Production and Cut Rejects

THE PACE of the chemical laboratory has been quickened many fold in plants producing rough and finished war materials through the use of modern equipment for rapid analysis, such as quick carbon and sulphur determinators and, to an even greater extent, by spectrographic equipment.

Not only is the actual analysis of material in process reported in one-tenth the usual time, but the new methods are so much easier and faster that many more determinations are made, thus giving to the operators a more continuous guide as to the analysis of their materials in process. This greatly speeds up production, for no particular process need be held up for any great length of time while awaiting an analysis. An even more important consideration is that rejections, consequently, are minimized.

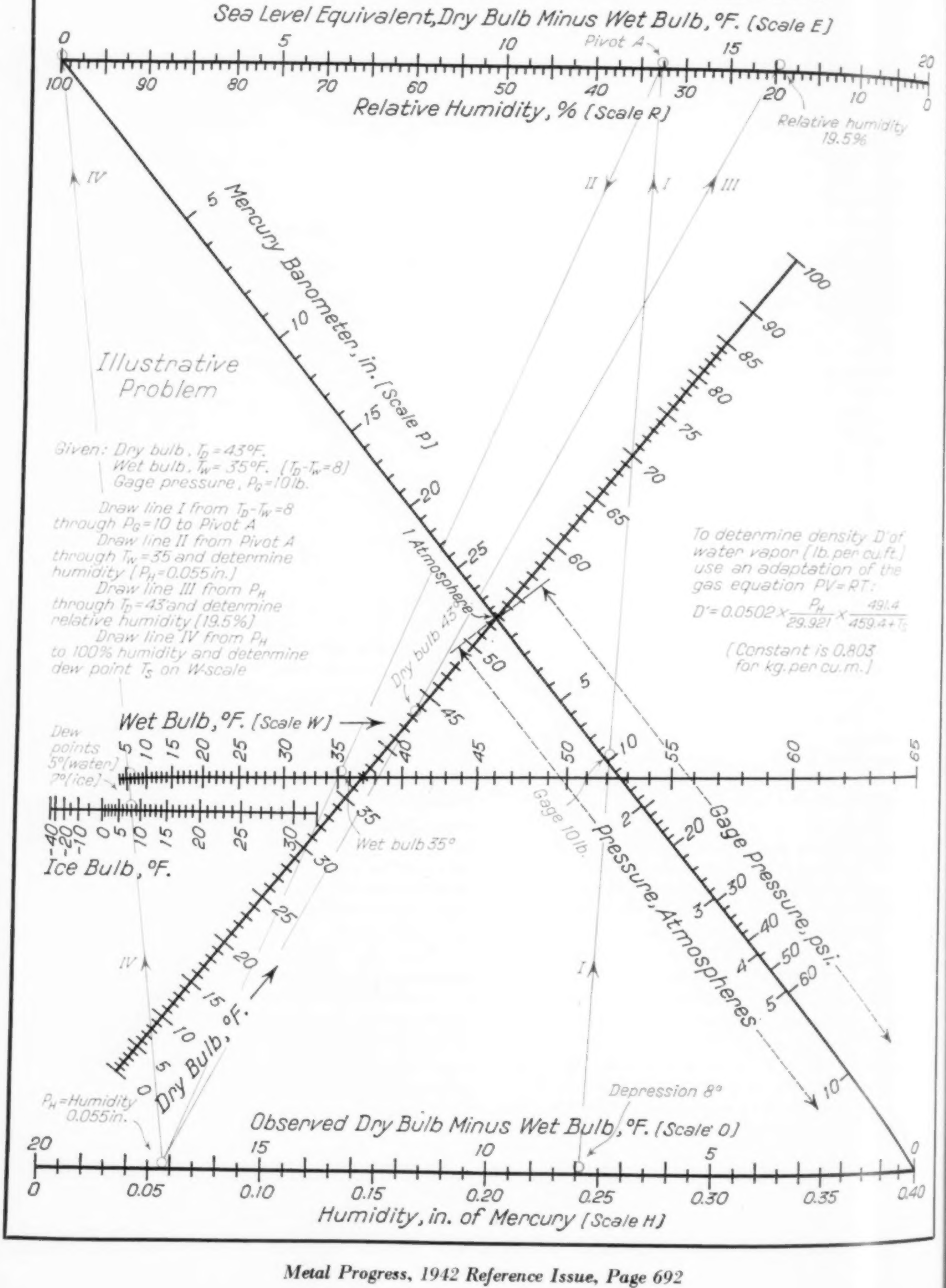
As manufacturers of practical spectrographic and other modern analysis equipment, the Harry W. Dietert Co. has met its production problems by making available to its workmen three educational classes. One is for advanced machine work, a second class is for beginners, and a third is a general class where motion pictures are used as the educational medium to show proper machining set-ups. The classes are held after working hours, yet men are paid at their regular rates while attending their respective study periods.

Personnel working on the design of the modern analysis equipment has made outstanding improvements in its simplification so that it may be operated more easily by laboratory help of less skill. It is now feasible to employ high school girls to operate much of it. This is another step toward relieving the ever increasing shortage of skilled and technical help.

H. W. Dietert
Harry W. Dietert Co.

Psychrometric Chart, Low Range

By Donald B. Brooks; National Bureau of Standards. Publication M-146



Five Times as Many Testing Machines

THERE IS NO DOUBT that, today, precision testing machines have become real production tools. America's war industries are mindful of the importance of testing in minimizing the loss of finished articles, thereby making for increased production of war products.

Some idea of the part such machines are playing in the manufacture of vital war materials may be gathered from our sales figures. In 1939, Riehle received 83 orders for testing machines. In 1941, its orders had increased to 248. From January to the end of June, 1942, it received orders for 212 testing machines — a fair indication that this year's volume will be more than five times that of 1939.

C. E. Peterson
Sales Department
Riehle Testing Machine Division
American Machine & Metals, Inc.

Helping Make "Armor-of-Proof"

IN THE PRESENT WAR EFFORT we make nothing that can fire at or be fired at the enemy, or ward off enemy fire, and nothing that can fly, float or roll on wheels. But we have a job to do.

"Armor-of-proof" (as the best armor was called in days of old) and arms that have been tested for "temper" and strength have been always so much embodied in all thoughts of battle, not only in history but also in mythology, that the quality of arms and armor as well as the quantity thereof has been recognized as a determinative factor in war. Being true of old, how much more must it be true in an age when fighting machines are as important in battle as the fighting men who operate them.

But modern arms and armor-of-proof must have numberless machines wherewith to prove them. Consequently we have enormously increased our output of "Rockwell" hardness testing machines, increased their variation in standard types to widen their adaptability and have, at the same time, increased their speed of operation.

Of course, tests for "temper" are no longer limited to sword blades and body armor. Aircraft engine cylinders, moving parts of engines, projectiles and cartridge cases, and a myriad of other items in metal that enter the production of the materiel of war now have hardness specifications on their blueprints.

Our increase to almost six times the old normal production has been accomplished by more machine tools, more men, more hours per man, more work shifts, numerous changes in materials and very busy engineering and design departments — in other words, by just good hard work.

In brief, our job, which we hope we are doing, has been to increase the assurance that the Allied Armies fight with armor that is truly "armor-of-proof".

Charles H. Wilson
President
Wilson Mechanical Instrument Co., Inc.

Range Finders, Binoculars, Military Cameras, Get Priority

MEETING THE REQUIREMENTS of the metallurgical industry for the optical instruments essential to increased production and quality control is an important but nevertheless small part of the over-all problem confronting the optical industry in the present emergency.

The would-be purchaser of a metallographic outfit, a spectrograph, a toolmaker's microscope, or a contour measuring projector, acute as his need may be, finds himself in direct competition — not only with others in the same condition but also the entire military establishment — for the available man-hours and machine-hours.

Today, every "peacetime" optical instrument has extensive military applications. No line of products can be discontinued entirely without adverse effect on the war effort. There is immediate necessity for range finders, aerial height finders and photographic lenses for aerial mapping and reconnaisance. They are demanded in unprecedented quantities. The problem does not resolve itself simply into "making this and not making that". *More of everything* is needed and needed *now*.

Fortunately, the actual picture is not as dark as might be supposed. An adequate supply of optical glass, the prime essential to all optical manufacture, has been available because

Bausch & Lomb's glass plant, started during World War I, has been maintained intact during the interim.

Second, by considering all of the skill and facilities as applicable to the war effort it has been possible to plan a larger share of production without conflict with direct military requirements, which obviously come first.

Third, fine understanding and cooperation on the part of educational and industrial users has made it possible to apportion resources and facilities to the greatest overall advantage.

I. L. NIXON
Sales Manager
Instrument Division
Bausch & Lomb Optical Co.

Continuous Check Against Tarnish when annealing shell cases

FURNACE BUILDERS, of course, have been hard put to deliver furnaces on urgent war orders, and Continental Industrial Engineers is no exception. One interesting and important aspect of our work in expediting the production of munitions, however, is in meeting demands for protective atmosphere to prevent scale, or even tarnish, of the hot metal in process, and the development of positive equipment for monitoring this operation in the form of a simple oxygen detector.

At the present time, for example, we are producing a very large order of equipment for shipment abroad through the American lease-lend which will be used for annealing steel shell casings. This operation requires close control of the furnace atmosphere during both the heating and cooling cycle. A serious deterioration of the furnace atmosphere would discolor or scale the shell casings and result in serious wear on the dies, since no pickling tanks are provided between drawing operations.

For guarding against this we are including Continental Oxygen Detector Units as standard equipment mounted on each panel board and provided with a liquid operated aspirator which continuously draws a small sample of furnace atmosphere to the detector. The latter consists of a glass bulb wherein is mounted a thin filament of special metal maintained at an accurately controlled temperature by electric heat and in contact with the furnace atmosphere under test. The filament is so designed that very small percentages of deleterious ingredients such as oxygen or water vapor will promptly rupture the filament, extinguish a green signal light in series, throw a switch to light a red signal light or ring a bell and thus advise the operator that it needs attention. After corrective measures have been taken to bring the furnace back to normal, the filament is readily replaced, and the equipment again stands guard.

CHARLES P. MASURE
Continental Industrial Engineers, Inc.

Control Equipment Speeds Metallurgical Processes — New and Old

PRODUCTION of The Foxboro Co., now triple its ordinary proportions, is flowing directly into the plants which are helping to arm America and our Allies. Every type of instrument has its part in this vital work, from the simple indicating thermometer on a core-baking oven to the recording potentiometer controllers, specially adapted to the involved processes of magnesium production.

The demand upon the nation's foundry capacity has correspondingly increased the demand for control equipment, especially for cupola blast, to improve operating efficiency. Many foundries with production schedules which seemed beyond reasonable possibility are now actually meeting them, because lost time has become productive time, the percentage of imperfect castings has been cut to a trifling figure, and the time required for machining has been greatly reduced.

Metal finishing is another field in which instrumentation is importantly aiding the cause of the Allies. In arsenals and plants producing military goods of many kinds, the relatively young processes of steel blacking are being carried out under the accurate and automatic control of instruments. Similar controllers are being employed in aircraft factories and numerous other plants where chromium plating provides the necessary wear resisting finish for engine parts and similar units.

In addition to the greatly increased need for pyrometric instruments for all the usual

metal working applications, there have been some interesting new developments in instrumentation such, for example, as those in connection with the stress-relieving of weldments for immobile equipment.

To meet the urgent demands, carrying high priority, for greater and speedier delivery, the Foxboro Co. has added new machine tools, expanded the employment roll, operated extra shifts, trained new workers, and tightened up still more on the production routine, to save the minutes which make the precious hours and days of wartime.

C. E. Sullivan
Vice-President
The Foxboro Company

Controls Production of Better War Products

BASICALLY, our function is to make good goods better. Specifically, Leeds & Northrup is making two types of contribution to the increased production of war goods.

Our first contribution is simply to manufacture as many as possible of the measuring instruments, telemeters, automatic controls and heat treating furnaces which are our established lines. Our second contribution toward victory is the great quantities of classified materiel for the armed services.

Of this second contribution nothing more can now be said. As to the first, the instruments are used widely in laboratories by scientists engaged in war work, for precise, dependable measurements of temperature, chemical purity, constituents of gases or metals, pH, voltage, resistance, current, capacitance, inductance, fault-location, and so on. Telemeters transmit facts about electric load and water level in power-plant operation.

Our "Micromax", "Metermax" and other automatic controllers for industrial processes are increasing output by preventing rejects in the manufacture of gasoline and rubber, steel, woolens, brass, aluminum, vitamins, explosives, chemicals and scores of other products which are going to war.

Our heat treating furnaces are doing an infinite number of precision jobs in the hardening and tempering of metal working tools for longer life and greater production; and in preventing rejects in the hardening, tempering, carburizing and nitriding of parts for guns, lathes, tanks, grinders, drill presses and boring mills, engines and motors, warplanes, balloons, trucks and torpedoes and practically all other materiel which contains heat treated parts. The object is not merely to heat treat them, but to heat treat them so well that they will last the longest possible time and hence be of greatest possible service in action.

We have been given the Army-Navy "E" for work well done along these lines.

Leeds & Northrup Co.

Substitute Materials Adapted to Temperature Controllers

PYROMETERS and temperature control instruments are playing a vitally important part in the war program.

Many industrial organizations such as heat treaters, smelters, foundries, as well as a variety of different processors, are still doing the same type of work they have always done — yet — it is somewhat different. The work is now being done for the armed forces! They are working on parts for tanks, ships, planes, submarines, guns, and the million and one things needed by our fighting boys — instead of washing machines, ironers, refrigerators, automobiles and the like.

Their need for precision instruments is still the same but they need many more of them.

Manufacturers of pyrometers and temperature controllers, while supplying a critically important cog in the gears of the modern war machine, have found it necessary to use substitute materials in place of those which, of necessity, must be used in munitions or the other "direct-contact" tools of war such as guns, airplanes, tanks, ships or submarines.

Sapphire bearings have been replaced with glass or steel.

Aluminum cases have been replaced with welded steel or brass.

Rubber gasketings have been replaced with various new synthetic developments.

Metal supporting parts and decorative parts have been replaced with plastics.

Nickel parts have been replaced with brass and other "not-so-critical" metals.

Rubber tubing has been replaced with synthetic tubing.

These substitutions, together with efforts toward simplification of design and standardization to just the few necessary models, are aiding Uncle Sam in his war program.

When we have succeeded in restoring peace and get back to the Golden Rule manner of living, many of these substitutes will continue, because they have in many instances proven to be of greater value than the materials specified in the original design.

M. J. Rauscher
Sales Manager
Illinois Testing Laboratories, Inc.

Laboratory Equipment for the Control of War Production

APPARATUS AND CHEMICALS furnished to industrial, governmental, educational and institutional laboratories by Fisher Scientific Co. and Eimer & Amend are playing a triple role in the nation's war effort — by controlling quality of war goods, by increasing production, and by aiding the search for better and substitute materials.

Every plant producing critical materials, every health agency safeguarding man-hours, and every research laboratory must be supplied with modern instruments, apparatus and reagent chemicals if the war effort is to equal and surpass the goals set up to beat the Axis. These tools make it possible for today's scientists to control quality, speed up production and devise new products just as they helped the peacetime laboratorian set the pace for America's high standard of living.

To implement these activities 10,000 items of apparatus and 20,000 different chemicals are available in supply. Shops are maintained to manufacture both glass and metal apparatus while a development laboratory is engaged in designing and testing new equipment to keep pace with the rapid advances of science.

Laboratory equipment is as essential to plant operation as raw material itself since every important step in the conversion to finished products is checked and controlled by the laboratory. Meeting these everyday requirements is an essential contribution to the war effort. By anticipating future developments in the physical sciences these principal supply firms to industrial laboratories are preparing not only for greater war production, but for peacetime accomplishments that are now submerged while the chemist devotes his talents to the immediate task.

Howard Draving
Advertising Manager
Fisher Scientific Co.

Electronic Gages Operate 'Round-the-Clock

REALIZING that the beginning of hostilities in Europe would increase the production schedules of this country, we began preparations for the added load on our special instruments (electronic gages for production control) about two years ago, resulting in a four-fold expansion of facilities.

A part of the war effort was the development of accessories to enable production instruments to handle hitherto impossible jobs. The economy of thus meeting an emergency is apparent, inasmuch as it allows a standard instrument to be used more hours and on hitherto nonexistent parts. While the knowledge of instrumentation necessary to allow intelligent development of these accessories is rather large, our expenditure in training additional personnel for this purpose has been justified.

Besides the special applications of instruments already in production, facilities have been increased many-fold in our laboratories devoted to the design and development of special instruments for production control. These instruments are built only for those purposes for which no other instrument is at present available.

Existing instruments which were operated by batteries have been re-designed for operation on a.c. power lines for use in war industries operating 24 hr. per day; existing battery operated equipment which is in the field can also be changed over whenever this is desirable. A part of our staff is also engaged in the re-designing of equipment to remove critical materials and increase ease of operation.

Donald E. Williamson
Manager
Physicists Research Co.

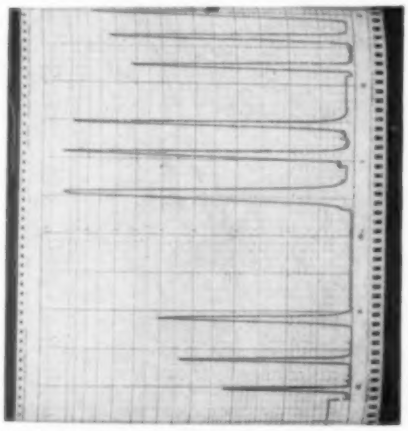
Microphotometer in an industrial laboratory. Scanning Unit in foreground. Speedomax Recorder in back.

Recording Microphotometers Speed Up Metal Analyses

About 500 non-ferrous alloy samples come in daily for analysis in each of the laboratories of a certain metal-producing company. On some of these samples, as many as nine quantitative determinations are made.

With this heavy volume of laboratory work to handle, the company has turned mainly to spectrographic analysis. They find that the speed and economy of this method "could not be approached by wet chemical methods" and the accuracy is so high that spectrographic results are even superior to chemical ones, in many cases.

To use the spectrograms for quantitative analysis, it is necessary to measure the density and position of their lines. This task is now done automatically; lines are measured and recorded by Knorr-Albers Recording Microphotometers, which have been so successful that each laboratory has at least one instrument.



Speedomax record of a spectrogram. Vertical position of each "spike" on the chart identifies a constituent in the sample; horizontal amplitude, when referred to calibration curves prepared by the user, gives percentage of the constituent.

An outstanding advantage of the equipment is that it does not involve photographic recording or the use of a high-sensitivity galvanometer. The entire measuring process is automatic: the user simply clamps the spectrogram in place, adjusts the controls, starts the mechanism—and the Speedomax draws an amplified record of the spectrographic lines.

If you'd like further information on the equipment, write for Catalog E-90(1).

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MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

Ruling a Grating on Smooth Metal
reveals hardness variations*

By Bo Ljunggren

A STUDY of hardness at grain boundaries was undertaken to throw some light on the theory that concentrations of "stranger" atoms or molecules occur near the grain boundaries in the "host" metal, invisible under the microscope, yet sufficient to hinder the normal processes of grain growth at moderately elevated temperatures. If such concentration existed it might be expected to cause some variation in hardness in the immediate locality. In any case, only an extremely thin molecular layer might be expected, and hence it is obvious that the method used to study local hardness should be extremely sensitive.

The method of Benedicks and Mets, namely, ruling a fine grating on a polished metal surface, was used as a starting point in the study. The equipment used was an automatic linear dividing machine obtained from the Société Genèvoise d'Instruments de Physique. When using this machine for ruling a grating on glass, as for a spectroscope, very fine scratches were obtained. Operation on smoothed metal was not very good until some adjustments were made to reduce vibration in the moving elements and to fix solidly the metal being ruled, the ruling speed reduced below 2.5 mm. per sec., and a thick grease lubricant used to cover the surface. The scratching tool and tool-holder were reduced to very small mass with high lateral stability, free from friction. The smallest ruling distance (distance between centers of adjacent scratches) was brought down to about 2 μ. The lowest pressure used was 0.05 g.

Various materials were tried for the scribers. One of the best is a sharp diamond splinter soldered into a tiny brass sphere, the latter then being placed correctly in the cupped end of a brass pencil and soldered tight. Action of such diamond points vary somewhat because of accidental circumstances, but each one is consistent with itself and very durable. Geometric shapes of hard metal pencils were then

(Continued on page 702)

*Abstracted from "Method of Sclero-Grating Employed for the Study of Grain Boundaries and of Nitrided Cases; Grain Structures Revealed by Cutting", Paper for British Iron and Steel Institute, 1940, describing work done under grant from Carnegie Research Fund.

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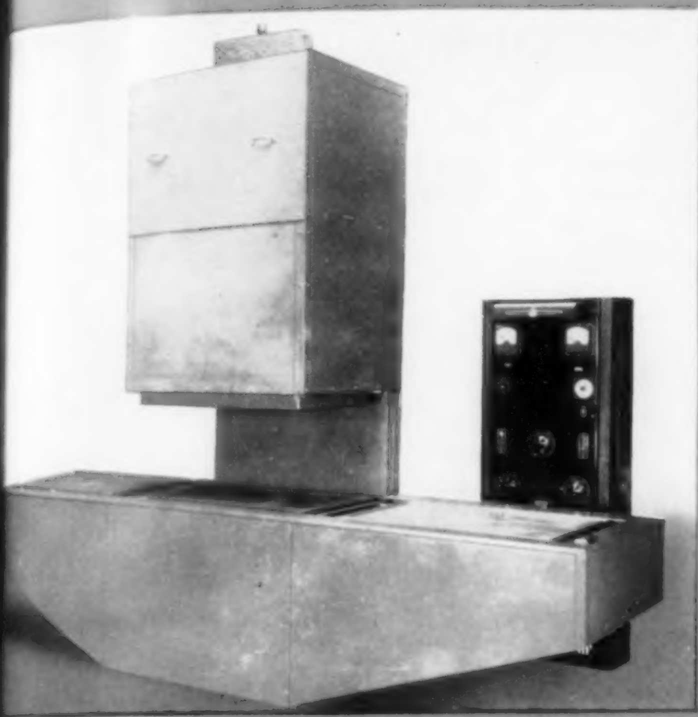

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Ruling a Grating

(*Continued from page 698*)

tried, such as cones and dihedral angles. A hard metal known as "Seco" was satisfactory, ground to a cone in a small watchmaker's lathe in good adjustment and free from loose play and vibration, using copper disks coated with levigated diamond powders of different grades of fineness. It is next to impossible to produce what is really a "point" at 1500 magnifications; the end is always poorly defined, either blunt or consisting of several tiny peaks. It was eventually found that a well-defined point is unnecessary for *qualitative* detection of hardness *differences*.

Sensitivity of the equipment described is particularly good at low pressures combined with a small ruling distance (close grating). For example it revealed the effect of cold working occurring under individual scratches in the preliminary grinding. The difference in ruling hardness in adjacent grains of pure iron was large enough to develop the grain structure.

The grain structure of pure lead could be beautifully developed by sclero-grating in much the same way as in etching. It was also thought that the irregularities in a microtome knife would function as a multiple-pointed scratching tool, and this was found true. On surfaces so prepared, a curious substructure was discovered, which is interpreted as being due to the presence of slight impurities, and recalls certain solidification structures, but of a much coarser character.

As a result of the general studies on steels two kinds of hardness variations were found:

1. Some inclusions, probably rich in MnO, are surrounded by a harder metal.

2. In a large grain the part of the grain situated nearest to the grain boundary visible is considerably harder than the portion of the grain further in. This greater hardness near the grain boundary, however, is distributed over a much greater depth than one might expect from a molecular enrichment.

The method was used to test the theory that dissolved atoms hamper grain growth, but gave negative results when testing various metals heat treated in air. However, when the annealing was done in an atmosphere of nitrogen, in which especially hard nitrides might be formed, a sensible hardness increase did occur, even though no precipitation in the grain boundaries was observed under the microscope.

On aluminum interesting observations were made, indicat-

(*Continued on page 704*)

Ruling a Grating

(Continued from page 702)

ing that lamellae of Al_3Fe, on annealing, projected from the surface. In the neighborhood of blowholes, the aluminum contained portions softer than the bulk; near large Al_3Fe inclusions the metal contained portions harder than the rest.

In iron, likewise, harder portions were found near sulphides.

Hardness of the micro-constituents of the nitrided case were also investigated. The structure is rather complicated, on account of the successive formation at low temperatures of various phases (in the same spot) with increasing nitrogen content.

1. In nitrided soft iron, the α phase is very much softer than the γ' phase. If the phases be ranged in the order of decreasing hardness, the sequence is $\epsilon, \gamma', \alpha$ — a sequence corresponding to the variation of the nitrogen content, ϵ having the highest nitrogen. This may explain the curve of hardness versus depth for nitrided soft irons, in which the hardness is found to decrease from the surface inwards.

Accidentally, a grain boundary was observed where no γ' phase could be found yet it possessed a greater hardness than that of the adjacent grains.

2. In nitrided chromium-vanadium steel, the α phase was found throughout to be appreciably harder than in the preceding case. The hardness also decreased inwards; certain anomalies in hardness at depth are explainable on the assumption that the alpha phase with low nitrogen is harder than the ϵ phase. The former contains not only one observable constituent, precipitated, but presumably also in a sub-microscopic state.

3. In nitrided chromium-aluminum steel, the α phase proved to be of comparatively still greater hardness. The phases behaved in respect to hardness very much as they did in the chromium-vanadium steel.

4. Hardness-depth curves obtained by using the sclerograting method and measuring the widths of the rulings gave fairly good agreement with those obtained by the Vickers method. The latter determinations indicated that the drop frequently occurring in the hardness-depth curves (at greater depths) might be explained by assuming that the residual layer of the nitrided case was so thin that it gave way under the indentation pressures.

5. Characteristic blisters and semicircular cracks formed on the continued nitriding of chromium-aluminum steel, with or without flaking, probably are due to local concentrations of gas.

Electrolytic Polishing of Metals

Compiled by G. E. Pellissier, Jr., Harold Markus, and Robert F. Mehl

Metal	Solution	C.D.§	Voltage	Temp. °C.	Time Min.	Remarks	Reference
All carbon steels, martensitic, pearlitic, and sorbitic; Armco and white cast iron; 3% silicon steel	Acetic anhydride, 765 cc. Perchloric acid,* 185 cc. sp.gr. 1.61 (65%) Distilled water, 50 cc. 0.5% Al	4 to 6	50†	<30	4 to 5	Prepare solution 24 hr. before using. Use moderate agitation. Al increases viscosity which permits more vigorous agitation and current density of 3. Can use at current density of 10 for austenitic steels. Prepare samples to 000 paper. Fe or Al cathode.	1
Steels (except low carbon)	Perchloric acid,* 54 cc. of 70% concentration Water, 146 cc. Alcohol with 3% ether, 800 cc.	2 to 6	70†	Room	½	Preliminary smoothing on 60-grit alundum wheel; stirring paddle set close to specimen operates at all times.	2
Austenitic steels‡	Acetic anhydride, Perchloric acid (65%) 2 parts to 1 part*	6	50†	<30	4 to 5	Same as items at top of column.	1
Iron and silicon-iron	Orthophosphoric acid sp.gr. 1.316	0.6	0.75 to 2.0			Iron cathode.	3
Tin	Perchloric acid * (sp.gr. 1.61), 194 cc. Acetic anhydride, 806 cc.	9 to 15	25 to 40†	15 to 22	8 to 10	Stir solution if length of electrolysis is over 10 min. Polish to 000 paper. Tin cathode. Electrodes 2 cm. apart.	4
Copper‡	Orthophosphoric acid sp.gr. 1.3 to 1.4	0.65 to 0.75	2	Room	>5	Polish to 0000. Copper cathode. Electrodes 2.2 cm. apart.	5
Copper‡	Pyrophosphoric acid 530 g. per l.	8 to 10	1.6 to 2.0	15 to 22	10 to 15	Polish to 00000 paper. Copper cathode.	6
Cobalt	Orthophosphoric acid sp.gr. 1.35		1.2			Rough metallographic polish. Cobalt cathode.	7
Aluminum‡	Perchloric acid* (sp.gr. 1.48) Acetic anhydride, 2 parts to 7 parts	3.0 to 5.0	50 to 100†	<50	15	Allow 4 to 5 g. per l. to enter solution. Polish to 000 paper. Aluminum cathode.	8
Zinc‡	Potassium hydroxide 25% solution	16	6	Room	15	0000 paper. Solution agitated by air or nitrogen. Copper cathode. Electrodes 2.5 to 15 mm. apart.	9
Lead	Acetic acid, 650 to 750 cc. Perchloric acid,* 350 to 250 cc.	1 to 2			3 to 5	0000 paper, horizontal anode. Use current density of 20 to 25 for 1 to 2 min. to remove flowed layer. Copper cathode.	6
Pb-Sn alloy	Same as above	2					6
Tin + 3% Sb	Same as for tin, above	9 to 15	25 to 40†	15 to 22	8 to 10	Same as for tin, above.	4
Copper + 3.2% Co Copper + 2.4% Fe	Orthophosphoric acid sp.gr. 1.35	0.07	2		5 to 10	Polish to 000 paper. Copper cathode. Electrodes horizontal and ½ in. apart.	10
Brass, 70-30,‡ (1 constituent)	Orthophosphoric acid 430 g. per l.	13 to 15	1 to 2	Room	10 to 15	File, swirl in 40% HNO_3 45 sec. Large size copper anode horizontal; electrodes ½ to 2 in. apart.	11
66.7-33.3 Brass‡	Orthophosphoric acid 990 g. per l.	2.5 to 3					6
Two-constituent 60-40 brass ‡	Pyrophosphoric acid 530 g. per l.	9 to 11	1.9				6
Aluminum bronze; Leaded bronze (85 Cu, 10 Sn, 3 Zn, 2 Pb)	Orthophosphoric acid 990 g. per l.	1 to 2					6
Phosphor bronze, silicon bronze, monel, nichrome, nickel, and ‡ metals	Methyl alcohol (abs.), Nitric acid (conc.), 2 parts to 1 part		40 to 50†	20 to 30	Seconds	Cathode of stainless steel cloth in bottom of dish. Distance between electrodes ½ to 1 in.	12

*Explosive Mixture! Mix slowly; keep cold. Do not use with bakelite or lucite mountings, or with bismuth alloys.
§Current density in amperes per square decimeter. †External applied voltage. ‡See last item in table.

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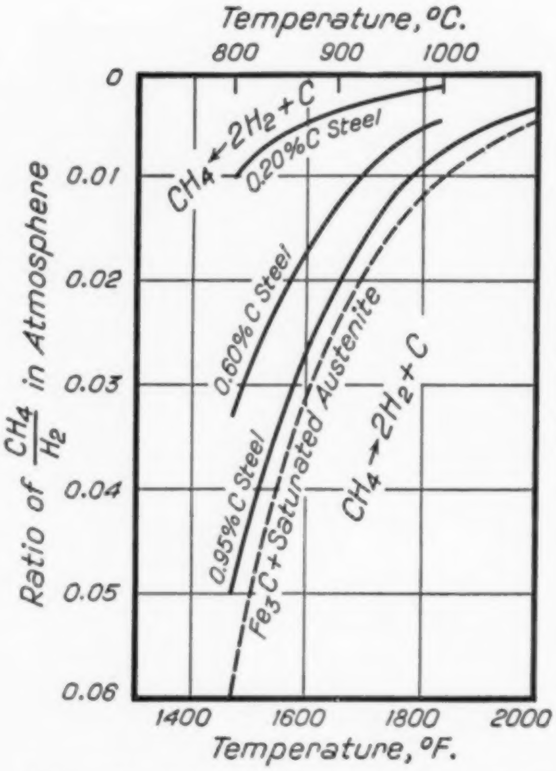
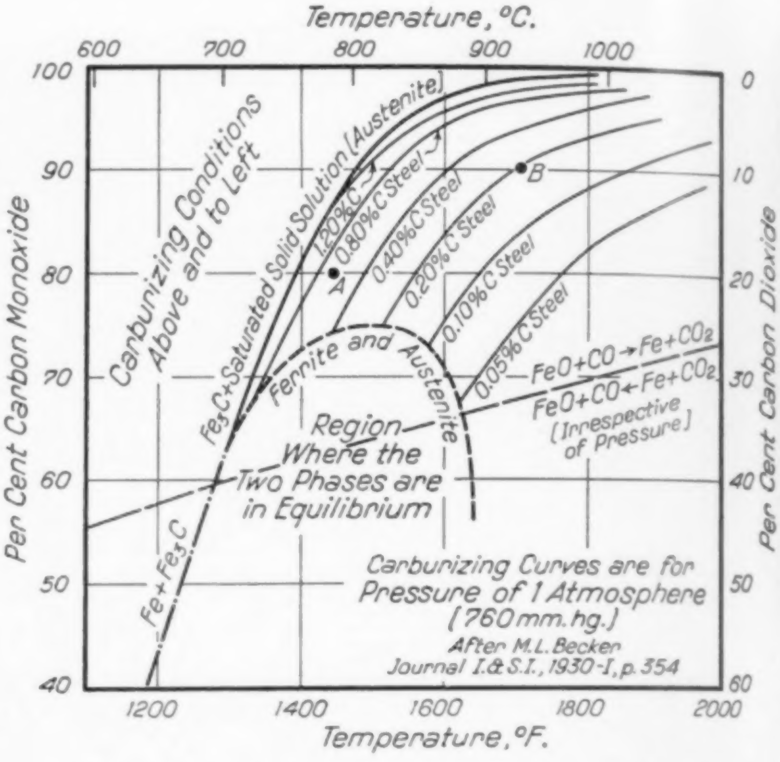
Equilibria for Gas-Steel Reactions

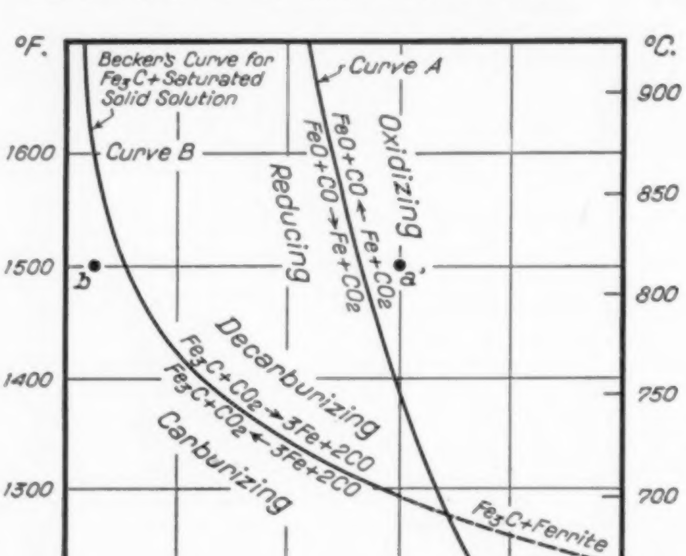
Relation Between Gas Composition, Temperature, and Carbon Content in Steel



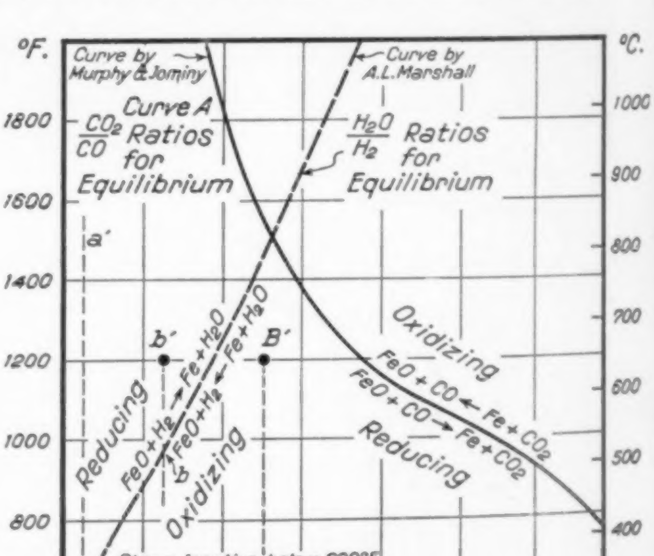
Above Curves, Adapted by Stansel From Sykes' Work, Indicate That Almost Pure H_2 Decarburizes Hot Steel (Conditions Above and Left of Corresponding Curves). Methane breaks down almost completely into carbon and hydrogen, carburizing steel (and depositing excess soot) at conditions below curves



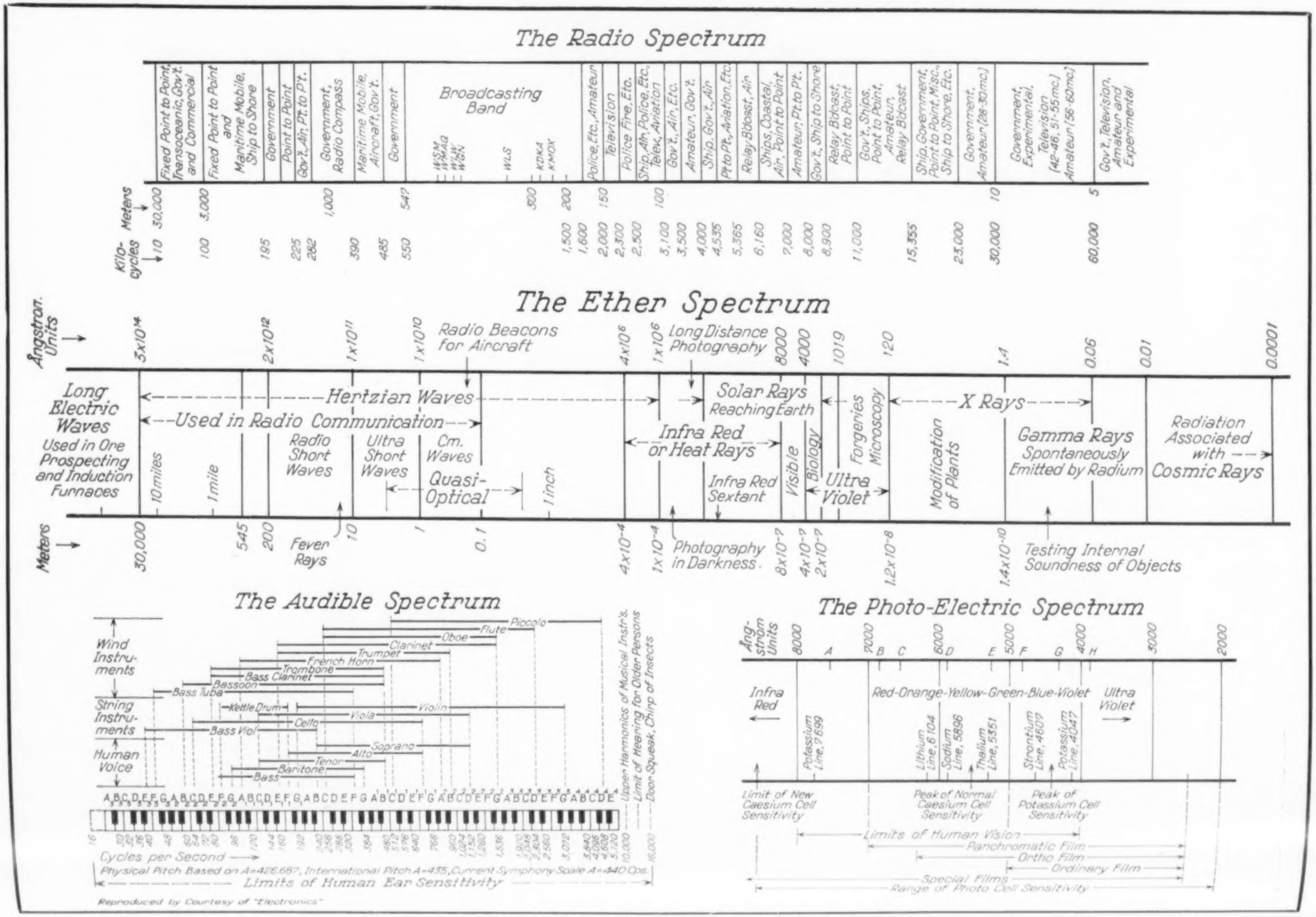
Carburizing Reactions Depend on Carbon in Steel. Thus: 80% CO, 20% CO_2, at 1450° F., (point *A*) will carburize 0.40% C steel and lower, but decarburize 0.80% C steel and higher. However 90% CO, 10% CO_2, at 1700° F., (point *B*) is relatively inert to 0.20% C steels, will carburize lower carbon and decarburize higher carbon steels. Partial pressures, i.e., $CO + CO_2 < 100\%$, raise curves and shift to left



Action of Carbon Oxides Depends on Temperature. For instance, a dried atmosphere containing 6% CO_2, and 10% CO or ratio 0.6 (easily secured by partial combustion of fuel gas) would tend both to reduce and carburize at a 1225° F. anneal (Point *a*), but would both decarburize and oxidize at 1500° F. (Point *a'*). For "bright hardening" the CO_2 must be reduced well below Curve *B* (for instance, 1/10 the CO, as Point *b*, at 1500° F.). The above statements neglect the fact that the pressure of $CO + CO_2$ is less than 1 atmosphere



Oxidizing Action of Steam May Be Counteracted by 20 Times As Much Hydrogen (Line *a-a'*). Larger proportions of steam may scale the metal during cooling (line *b'-b*). Oxidizing — and decarburizing — propensities of moist gas may likewise be counteracted by carrying excess CO in the mixed carbon oxides present in the furnace atmosphere (for instance, $CO_2 : CO = 0.5$, or line *B-B'*, on the reducing side of curve *A*)


The Radio Spectrum
Fixed Point to Point, Transoceanic, Gov't. and Commercial
Fixed Point to Point and Maritime Mobile, Ship to Shore
Government
Point to Point
Gov't., Air, Pt. to Pt.
Government, Radio Compass
Maritime Mobile, Aircraft, Gov't.
Government
Broadcasting Band
WSM WMAQ WLW WGN
WLS
KDKA KMOX
Police, Etc., Amateur
Television
Police Fire, Etc.
Ship, Air, Police, Etc., Telev., Aviation
Gov't., Air, Etc.
Amateur, Gov't.
Ship, Gov't., Air
Pt to Pt., Aviation, Etc.
Relay Bdcast, Air
Ships, Coastal, Air, Point to Point
Amateur, Pt. to Pt.
Gov't., Ship to Shore
Relay Bdcast, Point to Point
Gov't., Ships, Point to Point, Amateur, Relay Bdcast
Ship, Government, Point to Point, Misc., Ship to Shore, Etc.
Government, Amateur (28-30mc.)
Government, Experimental, Television (42-46, 51-55mc.) Amateur (56-60mc.)
Gov't., Television, Amateur and Experimental
Meters
30,000
3,000
1,000
547
300
200
150
100
10
5
Kilo-cycles
10
100
195
225
282
390
485
550
1,500
1,600
2,000
2,300
2,500
3,100
3,500
4,000
4,535
5,365
6,160
7,000
8,000
8,900
11,000
15,355
23,000
30,000
60,000
The Ether Spectrum
Angstron Units
3x10^14
2x10^12
1x10^11
1x10^10
Radio Beacons for Aircraft
4x10^6
1x10^6
Long Distance Photography
8000
4000
1019
120
1.4
0.06
0.01
0.0001
Long Electric Waves
Used in One Prospecting and Induction Furnaces
Hertzian Waves
Used in Radio Communication
10 miles
1 mile
Radio Short Waves
Ultra Short Waves
Cm. Waves
Quasi-Optical
1 inch
Infra Red or Heat Rays
Infra Red Sextant
Solar Rays Reaching Earth
Visible
Biology
Ultra Violet
Forgeries
Microscopy
X Rays
Modification of Plants
Gamma Rays Spontaneously Emitted by Radium
Radiation Associated with Cosmic Rays
Meters
30,000
545
200
Fever Rays
10
1
0.1
4x10^-4
1x10^-4
Photography in Darkness.
8x10^-7
4x10^-7
2x10^-7
1.2x10^-8
1.4x10^-10
Testing Internal Soundness of Objects
The Audible Spectrum
Wind Instruments
Piccolo
Flute
Oboe
Clarinet
Trumpet
French Horn
Trombone
Bass Clarinet
Bassoon
Bass Tuba
String Instruments
Kettle Drum
Violin
Viola
Cello
Bass Viol
Human Voice
Soprano
Alto
Tenor
Baritone
Bass
Upper Harmonics of Musical Instr's.
Limit of Hearing for Older Persons
Door Squeak, Chirp of Insects
Cycles per Second
Physical Pitch Based on A=426.667, International Pitch A=435, Current Symphony Scale A=440 Cps.
Limits of Human Ear Sensitivity
Reproduced by Courtesy of "Electronics"
The Photo-Electric Spectrum
Ang-strom Units
8000
7000
6000
5000
4000
3000
2000
Infra Red
Red-Orange-Yellow-Green-Blue-Violet
Ultra Violet
Potassium Line, 7699
Lithium Line, 6104
Sodium Line, 5896
Thalium Line, 5351
Strontium Line, 4607
Potassium Line, 4047
Limit of New Caesium Cell Sensitivity
Peak of Normal Caesium Cell Sensitivity
Peak of Potassium Cell Sensitivity
Limits of Human Vision
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Metal Working

More and Bigger Forging Machines

THE TREMENDOUS DEMAND for forgings in aircraft, tanks, ordnance and transport has placed a staggering load on the forging industry, which in turn has been passed on to the builders of forging equipment.

The need has been greatest for forging machines, forging presses and forging rolls of the larger sizes — in fact, principally for machines larger than were available only five years ago. The Ajax Mfg. Co. has responded with a plant addition to house the additional heavy machine tools required to double its output of these large machines. This includes another special floor-type planer of our own construction for machining the one-piece bed frames (weighing 145 tons) for the huge 8-in. forging machines. Since the problem is largely one of production, the output of all heavy machine tools, both new and old, has been increased by installing the most modern variable speed motor drives and by using portable shapers, boring bars and drills to relieve the primary tools of all secondary machining operations, and to shorten production time by performing two separate operations simultaneously.

Subcontracting has been limited to just what is necessary to keep abreast of primary operations, thereby keeping quality and scheduling under the control of our own experienced organization.

W. W. Criley
General Manager
The Ajax Mfg. Co.

Working 100% for Offensive War

BEFORE there will be a smashing second front in Europe, before there will be be full retribution in the Pacific, there will be a ring of offensive and defensive steel around every fighting man of the U. S. A. Chambersburg is working mightily to produce the drop hammers, the forging hammers, the "Cecostamps", and the presses necessary to forge that result.

Long before the jolt of the first foul blow from the Japs, this company had begun to enlarge its plant, to increase and train its personnel, to curtail its line of well-proven standard machines, and to analyze the prospective war requirements of the Nation for forgings and forging equipment.

When this survey revealed that steam drop hammers would be forging vitally needed parts from propeller blades to gun mounts, that board drop hammers would be turning out items ranging from aeroplane landing gears to buckets for superchargers, that our "Cecostamps" would be forming sheet steel and aluminum in virtually every aircraft plant in the country at a greater rate than ever before — then we acted vigorously in all departments to correlate our part in the program from foundry to forge shop.

None too soon! The nation at war has placed the forging program ahead of all others, giving it the highest of priorities. It has welcomed the results already achieved and has asked for greater ones. We at Chambersburg have been beating our schedules. A full 80% of our product goes to aircraft and air-engine factories, the rest to contractors to the Army and Navy. We are now setting for ourselves the nearly impossible task of making what the Air Corps and W.P.B. establish as the *optimum schedule*. That job will be licked too, as we have licked the others. No principle for increasing production, no opportunity for utilizing expanded sources of supply, no possibility for enlarged subcontracting has been overlooked.

Every employee in the organization stands ready to do his job, big or little, so the company — all of us together — can do its still bigger job.

H. L. Showalter, Jr.
Sales Manager
Chambersburg Eng. Co.

Bigger and Bigger Steam Hammers

FOR A NUMBER OF YEARS our organization had observed a steady increase in the maximum size of steam drop hammer required by the drop forging industry, and a steady increase year after year in the average size of such hammers produced. For instance, METAL PROGRESS reported in 1938 that a 35,000-lb. hammer was the largest in America. A year later it recorded another of the same rating but having, when a 44 by 90-in. die was included, a 52,000-lb. reciprocating weight. With this trend in view, Erie Foundry Co. developed designs suitable for even larger machines, and five years ago a plant expansion program was started to provide suitable foundry and machining facilities for the larger parts required. How large these parts are may be visualized by the fact that we have a traveling crane capable of handling 140 tons on a single hook, and a planer 16 ft. between housings. Using this equipment just prior to the outbreak of the War in Europe, 50,000-lb. hammers, bigger than anything in this country at the time, were shipped to both England and Russia and these machines are important factors in the aircraft manufacturing programs of our Allies.

This foresight in planning as early as 1937 for the manufacture of drop hammers larger than were then in general use has been a vital factor in the American airplane program. When the need arose for larger propeller blades, larger air-engine crankcases, and heavier landing gear, suitable Erie hammers were promptly available. When quantity production demanded mass manufacturing methods, still larger drop hammers were furnished, suitable for producing as a one-piece drop forging complete structural sections that had previously been fabricated by riveting and welding a multiplicity of small parts. Production time and man-hours in the aircraft plants were greatly reduced by this means.

Availability of these big drop hammers has influenced the design of many other instruments of war, including tanks, guns, ships. Forged links provide our Navy with anchor chains stronger and yet lighter by many tons. Diesel engine crankshafts are now drop forged, saving thousands of man-hours compared to the older methods of production.

Demand for such forge shop equipment has grown by leaps and bounds, and cannot be met by the facilities existing a few years ago. At the suggestion of Government agencies, but as a private enterprise and for its contribution to the war effort, Erie Foundry Co. has abandoned the foundry department from which it originally took its name, dismantled its foundry buildings, and is now constructing an addition to its machine shop which will approximately double its production capacity.

MACDONALD S. REED
Chief Engineer
Erie Foundry Co.

Advanced Forging Process and Machinery adapted to shell production

A CASUAL OBSERVER (if there are any such in munitions plants these days) cannot fail to marvel at the vital part big forging machines and presses are playing in our tremendous armament program.

This is no surprise to our engineers, however, because they anticipated the need by many years. An outstanding example of their early pioneering is in the field of shell forging. A forging machine method developed by National Machinery was disclosed in a paper read before the 1927 convention of the American Society for Steel Treating at Detroit. This method is in extensive use today because it insures a sound forging with proper grain flow, the over-all rate of production is unexcelled, the bore requires only a sand blast operation, and the tool life is unequalled. Furthermore, there is a vast saving in material, which reduces machining to a minimum, and diverts steel to other vital uses. As a result of this early pioneering, our forging machines were producing shell forgings even prior to Dunkirk.

Added to the unprecedented demand for shell forging machines is the vital and urgent requirement for our forging machines and Maxipresses for producing cylinders, pistons, valves, supercharger impellers, propellers, nose pieces, transmission gears, bearing races, and hundreds of other parts for ships, tanks, and trucks.

The addition of $500,000 worth of machine tools, with corresponding plant extension, has enabled us to meet the demands being made

upon us, and we are producing machinery for the forging industry at a rate that staggers even our imagination. It not only can be done — it is being done!

R. H. Jones
National Machinery Co.

Faster Hydraulic Equipment

SINCE SPEED and accurate production of war materials are now essential, it is understandable that fast forging and pressing equipment should be in overwhelming demand. The many types of self-contained presses built by Hydraulic Press Mfg. Co. for peaceful products have been universally adapted for producing war materiel. Among these are presses for drawing, tapering and heading steel and brass cartridge cases; presses for forging high explosive shells; presses for nosing and testing shells; gun barrel and armor plate straightening presses. Besides these specialized fields of endeavor, the standard "Fastraverse" metal drawing presses are used extensively for aircraft, supercharger and other deep drawn sheet metal parts. Our latest contributions to the metal working field are presses for forging steel, aluminum and magnesium using the "Fastraverse" principle. They cost less to install, are cheaper to operate, and require a minimum of maintenance. Probably no other new type of press has found such universal acceptance.

Both die forging and open forging presses are being turned out by mass production methods in a new and modern press plant, which has now been in operation for two years.

Auxiliary equipment of utmost reliability is a correlated essential. Modern hydraulic pumps, valves, cylinders and operating systems are also playing an important part in putting obsolete and unused hydraulic equipment back into active production. Our "Hydro-Power" pressure generating equipment powers many new machines requiring hydraulic drives, important among which are the tilting of electric steel furnaces, and motions for strip mill pay off reels and ship steering gears.

Although our service to the peacetime process industries has been partially restricted so that vital metal working plants can secure presses in the shortest time possible, one hydraulic press application which might be classified as a process-metal working type is powdered metallurgy. Our presses for briquetting powdered metals are pioneering an important industry which will undoubtedly find a large number of post-war applications.

Howard F. MacMillin
President
Hydraulic Press Mfg. Co.

Heavy Forgings Tripled
over previous record

TO THE BEST of our knowledge, every unit in the forge industry either has increased its facilities or is increasing at the present time. In addition, several new companies with steam-hydraulic press forging equipment are coming into the picture so that we would estimate an increase in large forging production, country-wide, better than three times the peak of 1929.

Upon our industry rests the responsibility for producing all the reciprocating and revolving parts in the new Navy and merchant marine, which include such items as steam and diesel engine crankshafts and connecting rods, line shafts, propeller shafts and reduction gears. More than that, we must produce all the gun barrels and breech mechanisms for the large guns of both the Army and Navy, not to mention the die blocks for forging the innumerable steel and aluminum drop forgings going into airplanes and tanks and their engines.

We believe that to date the industry has met the requirements of the nation, and we fully expect that it will continue to do so.

As far as Heppenstall's individual contribution to these objectives is concerned, we have rounded out the facilities at both our Pittsburgh and Bridgeport plants with the addition of heat treating and machining equipment to the end that we are now producing forgings and die blocks at a rate more than double any previous period in our history. We are building at Eddystone a plant for the U. S. Navy. Production started here in June while construction continued, and upon completion of this plant early in 1943, we expect an increase of approximately 50% of our present rate of production.

S. B. Heppenstall, Jr.
Vice-President
Heppenstall Co.

Standard Tolerances for Forgings up to 100 Lb.

Summary of Standards Adopted by Drop Forging Association, 1937

TOLERANCES, within the scope of these standards, shall be either "special" or "regular."

Special tolerances are those particularly noted on the drawings or in the specifications, and apply only to the particular dimension or thing noted. They may state any or all tolerances in any way as occasion may require. Regular tolerances apply in all other cases.

Regular tolerances in general forging practice are known as (*a*) "commercial standard," for general forging practice, or (*b*) if extra close work is desired involving additional expense and care in the production of forgings, "close standard" may be specified.

Class I—Thickness Tolerances

For drop hammer forgings, thickness tolerances shall apply to the overall thickness measured in a direction perpendicular to the fundamental parting plane of the dies.

For upset forgings, thickness tolerances shall apply to the metal actually enclosed and formed by the dies, measured parallel to the direction of travel of the ram.

Thickness Tolerances in Inches

Max. Net Weight	Commercial		Close	
	Minus	Plus	Minus	Plus
0.2	0.008	0.024	0.004	0.012
0.4	0.009	0.027	0.005	0.015
0.6	0.010	0.030	0.005	0.015
0.8	0.011	0.033	0.006	0.018
1	0.012	0.036	0.006	0.018
2	0.015	0.045	0.008	0.024
3	0.017	0.051	0.009	0.027
4	0.018	0.054	0.009	0.027
5	0.019	0.057	0.010	0.030
10	0.022	0.066	0.011	0.033
20	0.026	0.078	0.013	0.039
30	0.030	0.090	0.015	0.045
40	0.034	0.102	0.017	0.051
50	0.038	0.114	0.019	0.057
60	0.042	0.126	0.021	0.063
70	0.046	0.138	0.023	0.069
80	0.050	0.150	0.025	0.075
90	0.054	0.162	0.027	0.081
100	0.058	0.174	0.029	0.087

Class II—Width and Length Tolerances

Width and length tolerances shall be alike, and are classified in three subdivisions (*a*) shrinkage and die wear tolerance, (*b*) mismatching tolerance, (*c*) trimmed size tolerance.

For drop hammer forgings, width and length tolerances shall apply to the metal actually enclosed and formed by the die, as measured parallel to the fundamental parting plane of the dies.

For upset forgings, width and length tolerances shall apply to directions perpendicular to the direction of travel of the ram.

II(a)—Shrinkage and Die Wear Tolerances

See table below. These shall not be applied separately, but only as the sum of the two; they shall be measured in such a way as to eliminate draft or variation in draft. They apply to that part of the forging formed by a single die block, and to no dimension crossing the parting plane.

Shrinkage and Die Wear in Inches

Length or Width	Shrinkage: Commercial + or −	Shrinkage: Close + or −	Max. Net Weight	Die Wear: Commercial + or −	Die Wear: Close + or −
1 in.	0.003	0.002	1 lb.	0.032	0.016
2 in.	0.006	0.003	3 lb.	0.035	0.018
3 in.	0.009	0.005	5 lb.	0.038	0.019
4 in.	0.012	0.006	7 lb.	0.041	0.021
5 in.	0.015	0.008	9 lb.	0.044	0.022
6 in.	0.018	0.009	11 lb.	0.047	0.024
For each additional inch add	0.003	0.0015	For each additional 2 lb. add	0.003	0.0015
For example:			For example:		
7 in.	0.021	0.011	13 lb.	0.050	0.026
12 in.	0.036	0.018	21 lb.	0.062	0.031
18 in.	0.054	0.027	31 lb.	0.077	0.039
24 in.	0.072	0.036	41 lb.	0.092	0.046
36 in.	0.108	0.054	51 lb.	0.107	0.054
48 in.	0.144	0.072	71 lb.	0.137	0.069
60 in.	0.180	0.090	91 lb.	0.167	0.084

II(b)—Mismatching Tolerance

Mismatching is the displacement of a point in that part of a forging formed by one die block of a pair, from its desired position when located from the part of the forging formed in the other die block of the pair, measured in a projection parallel to the fundamental parting plane of the dies. It does not include any displacement caused by variation in thickness of the forging; mismatching tolerances are independent of and in addition to any others.

Mismatching Tolerance in Inches

Max. Net Weight	Commercial	Close
1 lb.	0.015	0.010
7 lb.	0.018	0.012
13 lb.	0.021	0.014
19 lb.	0.024	0.016
For additional 6 lb. add	0.003	0.002
For example:		
37 lb.	0.033	0.022
55 lb.	0.042	0.028
79 lb.	0.054	0.036
97 lb.	0.063	0.042

II(c)—Trimmed Size Tolerances

The trimmed size shall not be greater nor less than the limiting sizes at the parting plane imposed by the sum of the draft angle tolerances and the shrinkage and die wear tolerances.

Class III—Draft Angle Tolerances in Degrees

	Drop Forgings		Upset Forgings	
	Outside	Inside Holes	Outside	Inside Holes
Nominal angle	7	7 or 10	3	5
Commercial limits	0 to 10	0 to 13	0 to 5	0 to 8
Close limits	0 to 8	0 to 8	0 to 4	0 to 7

Class IV—Quantity Tolerances

Any quantity shipped within the quoted limits of over-run or under-run shall be considered as completing each release or part shipment of an order. Limits are as follows:

Quantity Tolerances

Number on Order	Over-run	Under-run
1 to 2	1 piece	0
3 to 5	2 pieces	1 piece
6 to 19	3 pieces	1 piece
20 to 29	4 pieces	2 pieces
30 to 39	5 pieces	2 pieces
40 to 49	6 pieces	3 pieces
50 to 59	7 pieces	3 pieces
60 to 69	8 pieces	4 pieces
70 to 79	9 pieces	4 pieces
80 to 99	10 pieces	5 pieces
100 to 199	10%	5.0%
200 to 299	9%	4.5%
300 to 599	8%	4.0%
600 to 1,249	7%	3.5%
1,250 to 2,999	6%	3.0%
3,000 to 9,999	5%	2.5%
10,000 to 39,999	4%	2.0%
40,000 to 299,999	3%	1.5%
300,000+	2%	1.0%

Class V—Fillet and Corner Tolerances

Fillet and corner tolerances apply to all intersecting surfaces even though drawings or models indicate sharp corners. If such drawings or models have or indicate (even though actual dimensions are not specified) fillet or corner dimensions of larger radii than the following standards, such larger dimensions shall be considered as actually specified and the tolerances shall be "special tolerances."

Where a corner tolerance applies on the meeting of two drafted surfaces, the tolerance shall apply to the narrow end of such meeting and the radius will increase toward the wide end. The total increase in the radius will equal the length of the drafted surface in inches, multiplied by the tangent of the nominal draft angle.

Fillet and Corner Tolerances

Max. Net Weight	Commercial	Close
0.3 lb.	3/32	3/64
1 lb.	1/8	1/16
3 lb.	5/32	5/64
10 lb.	3/16	3/32
30 lb.	7/32	7/64
100 lb.	1/4	1/8

Cutting Out Waste Time in the forge shop

IF ANYBODY had come to us a year ago and said, "I have enough business here in my brief case to double your output, can you do it?" we might have replied, "Can you fetch the sun for us, without burning your hands?" Our hammers were practically at peak output at that time. So when the exigencies of the war demanded that we more than double our production, we had to do some lucubration — in plain language, burn some midnight oil.

We revamped our entire *modus operandi.* By lopping off a minute here and there, reducing handling, building more furnaces so that heats would always be waiting to go under the hammers, hiring unskilled labor to serve our hammermen so that they could concentrate on producing forgings, adding a 14,000-lb. flat die hammer, a 20,000-lb. drop hammer, and three single frame hammers which we were lucky to obtain, we finally hit the bull's-eye.

Now that we are accustomed to the idea of doing the impossible, we have embarked on a plant expansion program — or rather have set up a subsidiary, the Kropp Forge Aviation Co. — which will quadruple our present drop forging capacity. By employing the methods involved in our first "double-up", we will need only a little more than half again as much equipment as is used at present.

Every man jack of us at Kropp has his shoulder to the wheel. We know it's do or die — and we intend to live!

ROY A. KROPP
President
Kropp Forge Co.

Re-educated Workmen Build Heavy Machinery

THE QUESTION has been asked, "What did Farrel-Birmingham Co. do that is so unusual, and enable it to meet its time schedule of deliveries, even with the intensive cooperation of its personnel?" The answer is, "Nothing unusual, but it started early. It started early to build and modernize its plants and equipment and to train its own workers."

Briefly, through scientific planning, the following steps were taken to convert the three plants from unruffled manufacture of a staple line of rolls and heavy machinery into a war industry meeting the needs of the present emergency so well as to warrant the Navy "E" burgee for excellence:

1. The foundries were enlarged and equipped with modern sand conditioners and core and molding machines. The Randupson cement molding process was installed together with improved metallurgical supervision and methods.

2. Machine shops have been enlarged, new machines set up and modern tools and metals acquired. A new plant is now going up, adjacent to the Buffalo plant, where greatly needed gears will be cut.

3. Engineering production has been revitalized, planning, cost and control and inspection departments reorganized, and new departments installed for setting up standards and wage incentives for both foundry and machine shops.

4. The welding department has been increased six-fold.

5. An in-plant training program for apprentices and machine operators, established many years ago, was intensified. During the past 18 months such educational work has become a major activity, adequately staffed, equipped and housed. Many welders, assemblymen and machine operators have been trained by the so-called learner method involving home study courses, classroom attendance and instruction in the shops.

Regular apprenticeship now includes machinists, draftsmen, wood pattern makers, electricians, molders and core makers. Apprentices are indentured for four and five years and the courses include classroom instruction, home study, and assignment to different types of machines and related departments. Graduate apprentices and older craftsmen have been given special training and set up as foremen, inspectors, service men and routers, or placed in other key positions.

At present, women are being trained to replace men called to the service, and are efficiently working in the laboratories, assembly rooms, tool rooms, tool cribs, machine shops, and as crane operators.

R. G. HARTWELL
Apprentice Supervisor
Farrel-Birmingham Company, Inc.

Welding Expands Six-Fold

THE increased requirements on the welding industry resulting from the war effort are probably greater than those on any industry which now manufactures its standard type of product. As a consequence the welding industry has increased its output both in machines and electrodes by more than six times in the last 24 months. This record is not only remarkable in itself, but it also is remarkable because of the fact that no one outside of the industry prepared it for this increase by forecasting what was to be needed. The industry itself made the investigation, came to the conclusion and made the increase in production capacity. That it has judged the requirements accurately can be shown by the fact that, as far as is known, not one activity which could get priority has been held up one minute for lack of welding equipment and supplies.

How fundamentally war manufacturing has been changed by welding can be illustrated by the fact that this six-fold increase was needed and has been used without any great increase in the total steel production. This means that six times as much welding is done per ton of steel now as was done two years ago. We can safely say that there will be a further increase, eventually, because of the economies which welding introduces in manufacturing of more than three times its present consumption.

Changes as radical as this generally take place slowly. It is a fine compliment to metal fabricators generally that they have been able to apply this new method of manufacture with its outstanding economies so rapidly in this great crisis.

J. F. Lincoln
President
The Lincoln Electric Co.

Plate Rider Cuts Compound Bevels on Armor

NEW USES for the oxy-acetylene flame and the cutting-oxygen stream have been greatly accelerated. This widened and intensified application of the processes has developed new apparatus and techniques which are naturally finding widest application in the steel, shipbuilding, aircraft and other industries most directly concerned with war production.

Applications in the steel industry include a number of essential processes. These are conditioning of steel ingots or billets by hand or by mechanical means, hardening or softening of steel surfaces, removal of scale from the surfaces, and cutting of the steel to proper size and shape. Acute demands for high-production cut-off equipment have led to the development of new principles and new machines for the flame-cutting of billets, blooms, slabs and ingots, either hot or cold. The new requirements not only result from a lack of cold shears and saws, but are equally due to improvements in the adaptability of cutting equipment and increased speed and economy of the process.

War production has greatly stimulated the trimming, shaping and beveling of plates by oxy-acetylene cutting in all types of fabricating shops, particularly in shipyards. Yards using a combination of cutting and welding are obtaining remarkable production rates, and it is the generally held opinion that the combination of the two processes is one of the most important reasons for the high schedule of ship construction in the United States today. Fabricating shops are finding indispensable the shape-cutting by oxy-acetylene flame. Not only is it possible to turn out work faster, but the process leaves presses, planers, and other machines free for other needed work. To speed production further, the trend has been towards multiple blowpipe operation, or the cutting of stacked plates. Possibly the most important cutting development of the past 12 months has been the use of two or more blowpipes supported by a suitable plate-riding device, operating simultaneously to produce a multi-faced edge for welding, on tank armor.

The inherent advantages of flame hardening have resulted in the adoption of the process for a variety of important applications. Principal among these are tank parts — including sprocket teeth, the raceways of turret rings, and grousers — as well as parts for automatic rifles.

J. H. Zimmerman
Manager, Development Dept.
The Linde Air Products Co.

Welds Armor Four Times as Fast

EFFORTS of the stainless steel electrode industry during the past six months have been characterized by two major objectives, *(a)* conservation of chromium and nickel, and *(b)* development of an electrode to reduce welding time on armor plate. In achieving the first objective we have a modified 18-8 electrode which saves about 35% of the chromium and nickel when compared to the electrode type previously used. Intensive research is now going forward to increase still more this saving of strategic alloys.

Development of larger diameter electrodes with a maximum size of ½ in. diameter and a length of 28 in. has increased the deposition rate four times over good practices prior to their use. This will result in a corresponding reduction in the number of welding machines and operators required to meet this year's schedule of war products. Furthermore, these large electrodes have been designed to operate on both alternating and direct current, which permits all types of equipment to be used.

The ingenuity of this youngest of metallurgical industries — the welding industry — is almost limitless, and the developments of the future can easily prove to be as effective as those of the past.

EDWARD J. BRADY
General Manager
Alloy Rods Co.

Look-Learn Films on Welding speed up instruction 20%

DURING the past year, the importance of arc welding in the war effort has been reflected in unprecedented demand for both the equipment and the manpower required for successful application of the process. This demand has been met by unprecedented action on the part of manufacturers.

The entire industry has greatly increased its capacity for manufacturing arc welders and electrodes and is still expanding facilities as fast as needed materials can be obtained. General Electric Co. has, at the same time, directed the efforts of all field-application engineers toward helping users to increase both speed and efficiency of arc welding. The use of larger electrodes — which are easier to make, more efficient to use, and which result in much faster production — has been recommended wherever practical. Likewise, the use of alternating current welding machines has been encouraged where applicable because they can use these larger electrodes with much better success and efficiency.

The smoke of the raid on Pearl Harbor had hardly lifted before an active campaign of conservation was initiated throughout the industry, assisting all users to avoid waste of electrodes. This campaign was assisted by many novel aids, such as General Electric's production labels on all electrodes to tell users what they should expect in production when welding follows good practice. An "Arc Welderule" was also produced by means of which operators, supervisors, engineers, and others could quickly calculate the production obtainable.

To meet the extraordinary demand for trained operators, General Electric is sponsoring production and distribution of six full-color talkies. Although these films have been available only a short time, more than 1000 copies are at work throughout vocational training centers today. It has been conservatively estimated by welding instructors that these movies have speeded up training as much as 20%.

Although considerable progress has already been made, we are inclined to view accomplishments to date as only the beginning of the ultimate production which will be required for final victory.

C. I. MACGUFFIE
Manager, Electric Welding Sales
Industrial Department
General Electric Co.

Saves Tons of Chromium and Nickel

MANUFACTURERS of stainless steel and alloy electrodes are faced with multiple problems which are the direct result of the demands of the war program. Unlike the general condition among steel electrode manufacturers, the stainless producer has a much more serious burden than merely to step up production to meet the accelerated war needs.

Stainless requires chromium and nickel,

and it is no secret that the supply of these vital materials is inadequate to meet the demand. When this scarcity of materials was superimposed on a demand which in 1942 is nine times that of 1940, it is obvious that the conservation of vital materials posed problems of greater basic importance than that of manufacturing capacity.

Since adequate capacity has been available, the problem of conserving nickel and chromium was the next step. Arcos Corp. had been experimenting for four years on a substitute for the grade containing 25% nickel and 20% chromium (25-20) — not, at first, for the purpose of reducing the use of nickel or chromium, but to obtain better mechanical properties of the welded joint, and qualities that more exactly matched those of the air-hardenable steels to be welded. When the necessity for a lower alloy content arose, the background of this research was particularly valuable. As a result, the so-called "modified 19-9 electrode" not only meets all the requirements of the 25-20 grade but also in some respects is superior to it. The modified grade reduces the content of nickel and chromium in the alloy from almost 50% to less than 30%, and will constitute an estimated saving in 1943 of several thousand tons of these critical metals.

This new product developed by Arcos has important modifying elements, mostly as constituents of the core wire rather than in the coating, which enhance weldability and metallurgical qualities of the weld metal.

R. D. Thomas
President
Arcos Corp.

Throw *Your* Scrap Into the Fight

Courtesy (Copyright) Wickwire Spencer Steel Co.

Alloy Powder Produced in Quantity

POWDERED METALS, along with a great number of other products of other peaceful industries, have suffered the dislocation of changing from civilian business to the war effort.

During normal times, the types of pyrotechnic powders available are few, due to the limited demand for this type of product. However, with the advent of the war, not only are large quantities required, but new and special types as well. It might be stated that the powdered metal industry in this country has stepped out and done an exceptionally fine job in a short period of time in not only producing special types of powders as to chemical and physical properties, adapted for conventional uses, but large quantities of powders for use by our armed forces for pyrotechnic and ammunition manufacture.

The art of manufacture, through the stimulation of the war effort, has been perfected so that today we find non-ferrous *alloy* powders being produced. The technique of fabricating these powders into parts by powder metallurgical methods is well advanced. Large quantities of such alloy powders are now being used.

In the ferrous field, great activity has continued. As an outgrowth our industry in general has learned many interesting fields of new use, as well as the limitations that are placed on an iron powder. We are learning that electrolytic powders may be used for some applications, hydrogen reduced oxides for others, and still another field will require a powder reduced from the oxide with carbon monoxide gas.

It is certain that this young industry will emerge in the next two to three years with a much sounder background and a well established place in the field of metal working.

H. E. Hall
General Manager
Metals Disintegrating Co.

Powdered Iron Makes Superior Cores for Radio Transformers

A LITTLE-NOTICED metallurgical development of the past five years has been the expanding use of powdered iron cores in radio and communications apparatus. We believe it interesting and suggestive to trace the background of this technical development.

Iron, in the form of rods or iron filings, has been used in low frequency transformers for many years. The advent of finely divided iron powders, coming at the same time as notable advancements in the ceramic arts, combined to make possible the production of iron cores with the individual iron particles insulated from each other, the resultant structure being magnetically useful in radio apparatus.

A most startling advance has been registered through the replacement of bulky, aluminum-cased, air tuned intermediate frequency transformers with very efficient, small sized assemblies of coil and iron core, arranged to yield the highest efficiency. The space occupied by these new coils and cores is often not much larger than a spool of thread.

Another development is "permeability tuning", a system which employs moving iron cores inside tuning coils. This design has been very successful in portable radio sets, providing vibration-proof, trouble-free tuning. When civilian motor car construction commences again many wartime advancements in this art will contribute to even better radio performance in passenger automobiles.

Last, and not least, is the fact that, combined with this reduction in space for radio transformers, there has been a reduction in copper requirements. The saving in this valuable metal has been very much worth while, and is principally due to the substitution of iron cores and cups in modern transformer design.

American industry can certainly look forward to many valuable electronic devices for production control. A small part of the efficiency developed in these devices will be in many cases attributable to the advancement in the transformer art, as represented by the fabrication of cores of powdered iron.

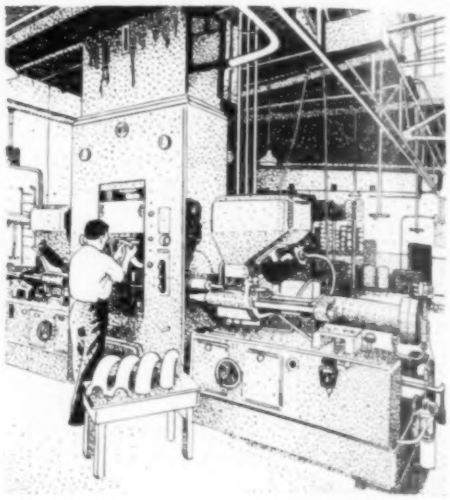
A. B. Mullaly
Advance Solvents & Chemical Corp.

More Products From Powdered Metals
rather than different processes

POWDER METALLURGY is taking a prominent place in the war industry, just as it did in the automotive industry previous to Pearl Harbor. The same equipment that compressed and finished bearings, gears and other parts for automobiles and peaceful industry is now making parts for tanks, jeeps, airplanes, guns and shells. In most cases it was merely necessary to make new dies for the existing presses and revise the sintering procedures to meet the new specifications. No wholesale replacing of capital equipment was required.

One of the largest expansions in powder metallurgy has naturally been in the field of ordnance. Another very important application has been in the carbide tool industry to meet the demand for more and faster cutting tools in the metal working industries. Powder metallurgy is also playing an important role in the communications field, for new use on land and sea and in the air.

With the expansion of uses and requirements has come a similar expansion in the supply of the powdered metals themselves. One notes with interest and pride the rapid development of several domestic sources for powdered iron to supplement our stocks of Swedish iron powder.



Many of the interesting wartime developments as well as the intense current research will be of permanent benefit to industry later.

L. H. Bailey
Chief Chemical Engineer
F. J. Stokes Machine Co.

Five Methods Devised for Economical Tool Selection

DEFENSE EFFORTS and the war program have tremendously speeded up and broadened the general application of cemented carbide and the newer non-ferrous cutting-tool alloys. The hurried conversion to war work of the metal working industry has also employed a countless number of inexperienced "machinists". They hear first of the production advantages of the new tool materials before they learn the technique of using them.

The carbide tool industry as a whole has done a lot in the last two years in the way of standardization to facilitate and simplify the application and most effective use of these tools. Such standardization has also enabled us to make more tools with existing equipment. In addition we have considerably expanded our facilities for production. An unusually large amount of work has been done in the past year on special grades of cemented carbides required by new machines and new materials brought into the shops because of the war effort. This year we have also classified into five methods the various ways that these maximum production cutting-tools can be applied. By using one or more of these methods the customer can further standardize his use of these tools.

Method One is for standard, finish-ground ready to use, carbide tipped tools. This method has a price and delivery advantage to the user and by making these standard tools in quantities the tool manufacturer can turn out more tools than though his facilities were tied up in making specials. There are several hundred tools in this standard group and users are urged to select them whenever possible.

Method Two embraces milled and brazed carbide tipped tools on which all grinding is done by the customer. This method is recommended for all users who have tool grinding equipment, thus leaving the tool manufacturer's equipment for those who have to have it.

Method Three embraces all special tools made to order. This method is for those who need help in tooling up and haven't the equipment with which to make their own tools. Such special made-to-order tools should be limited to the comparatively few cases where nothing else will do.

Method Four is for the user who buys carbide blanks and makes his own tools. In the present emergency every tool user who can should braze and grind his own tools.

There will be many cases where cemented carbide tools will not work effectively for maximum cutting. In these cases we recommend Method Five which embraces the many tools made from our non-ferrous cast alloy known as Tantung.

R. H. McCormick
Advertising Manager
Vascoloy-Ramet Corp.

Faster Cutting With Multi-Carbide Tools

STEEL CUTTING with cemented carbide tools has now become the accepted practice. This development, accelerated by war demands, was made possible by the invention of compositions having in addition to the high hardness typical of all cemented carbide (from Rockwell C-76 to 80 as compared to hardened toolsteel of C-64 to 67), the high strength against mechanical shock and resistance to "crater" formation necessary for tools for machining steel. Uniform crater-resisting cemented carbide tool metals

containing multi-carbide intermetallic compounds are now widely used.

One pound of tungsten in the form of tipped tools of these cemented compositions turns out as much work as 60 lb. of tungsten in the form of 18% tungsten toolsteel. Furthermore the output of lathes, boring mills and other machines equipped with these new tools is increased 30 to 100%, due to the faster cutting speeds. They enable designer and factory to employ steel parts up to hardnesses of 550 Brinell, and yet machine them economically and accurately in the heat treated state. Interrupted lathe cuts, and the milling of steel, which awaited the development of these higher strength carbide compositions are now successfully done in many places.

As demand has increased and the production changed from a semi-laboratory to a larger scale, economies in carbide production became possible; simultaneously the importance of the cemented carbide industry merited careful scientific research which enabled the manufacturers to shove up the standards of quality and uniformity until, from all accounts, American steel-cutting carbide is by far the best in the world.

PHILIP M. MCKENNA
President
McKenna Metals Co.

Hyper-Mills Cut Double to Six Times as Much Metal

FROM the experiences of a rather hectic year, some things concerning Firth-Sterling's activities stand out in high-light:

Increased production of essential toolsteels and sintered carbides in all departments to several times our pre-war volume.

New high speed steels were developed, and other grades modified to conserve alloys.

We developed the titanium-tungsten type of sintered carbide for cutting the hard and heat treated steels used in munitions.

Perfected the use of sintered carbide dies for drawing shell casings for both small arm and artillery ammunition.

We made drastic reductions in the price of carbides, permitting their widespread use which, in our opinion, has contributed very materially to the rapid production of the many parts of mechanized equipment which are so difficult to machine.

"Hyper-Milling" — a new method of using Firthite-tipped milling cutters, with negative rake and helix angles — may ultimately be considered one of the year's outstanding developments, because it permits extraordinary cutting speeds, makes practicable the milling of heat treated alloy steels, produces highly burnished surfaces, and more than doubles the output of milling operations on steel. Paradoxical as it seems, this method was first used by reversing the blades and running a cutter backwards!

DONALD G. CLARK
Vice-President
Firth-Sterling Steel Co.

Standardized Tools Speed Production

OF ALL the contributions which cemented carbides have made toward speeding the war production effort, the most outstanding perhaps is the job their manufacturers have done in meeting all demands for tools and dies — and meeting them promptly. As near as we are able to determine from estimates by tool buyers, the time it takes to get the average carbide tool on the job after an order for it has been placed is about one-half to one-third that for the delivery of cutting tools generally. This situation is due to several circumstances.

Part of this is due to the fact that the cemented carbide industry was not caught napping but had provided reserve capacity for increased production. True enough, that capacity soon proved insufficient to meet the final demand, but the reserve was there to take up the slack while additional facilities were being promptly provided.

Part of it is due to the program looking toward tool standardization which had preceded even the lend-lease program, making it possible to turn out standardized tools in mass production for quick delivery to war industries.

Part of it was due also to the expansion in and extensive training of factory and field engineering staffs, who were thus able to step in and cure many headaches for a metal-working industry suddenly confronted with the job of building entirely new kinds of things.

As a result carbide tools and carbide tool engineers were able to show industry how to multiply by several times again the anticipated production of tanks. They were able to bring order out of a confusing multiplicity of die designs and sizes used by cartridge case manufacturers; standardization of such dies greatly expedited deliveries.

Even since the start of hostilities, entirely new types of tools have been developed by carbide manufacturers for war production, including special tools for faster shell production, "shear type" tools for machining necessary but almost unmachinable alloys, simple tools to prepare rough surfaces for metallizing, new types of drills to speed the manufacture of gun barrels (now 'way ahead of schedule). Quite a few of these tools are now in production as "standards".

W. G. Robbins
President
Carboloy Co., Inc.

More and Better Grinding Materials
despite lack of imported ingredients

THE POSITION of such manufacturers of abrasive and refractory products as The Carborundum Co. in the tremendous war program is rather unique. It should be remembered that abrasive products, particularly grinding wheels, enter into the making of every weapon and product of the war industry. Precision parts of the airplane engine, the tank and truck motor, intricate parts of the machine guns, shells and projectiles, artillery and naval guns, rifles and hundreds of articles of equipment must be ground, shaped, finished and polished with modern abrasive products. Then, too, in many of the power plants, in chemical and process industries, in the heat treating furnaces, super-refractory products such as are manufactured by this company are among the most essential tools.

The great demands for abrasives, plus the need for striving towards increased production and greater accuracy in interchangeable parts, have led to the development of improved grinding wheels and of ways and means for greatly increasing their production. Problems in meeting the tremendously increased demands placed upon it are exceptional in that it necessitated expansion not only in the plants which manufacture the abrasive grinding wheels and other abrasive and refractory products, but also expansion in its crude abrasive plants which produce the materials from which these finished products are manufactured. Additional lands had to be purchased, new buildings erected, new power contracts negotiated, increased raw materials supplied and handling facilities arranged for. These programs were started in 1938 so that to date it has been possible to meet the ever-increasing demands.

After facilities were arranged for, many manufacturing problems have confronted the abrasive manufacturer. In addition to the increased demands for normal uses, he has had to find an acceptable substitute, in quantity, for materials like Turkish emery and corundum.

In manufacturing Carborundum products it has been necessary to locate, test, and put into commercial use substitutes for the fluxing ingredients of bonds formerly obtained only in Asia Minor. Intensive research has carried out the necessary tests and surveys for basic materials likely to be curtailed. New resin-bonded grinding wheels and centerless feed wheels have been developed to conserve the dwindling supply of rubber. Many items containing scarce materials, such as nickel, are being reclaimed to be used again and again.

In many of its fields, The Carborundum Co. has increased its production by increments ranging from 50 to 500%. Expansion programs now under way are designed to meet a still increasing demand for abrasives and refractories.

Supplementing this manufacturing effort a wide engineering service has been rendered by our technical staffs. It is the duty of these men to help the abrasive user to get the most and the best out of his grinding wheels and similar products; to apply intelligently their engineering knowledge of the proper application of refractory products in boiler furnaces, heat treating furnaces, kilns and other installations working at highest temperatures, in order to increase production and lower costs. Then, too, educational programs developed by The Carborundum Co. teach thousands of trainees and apprentices who will become the skilled grinder hands of tomorrow.

H. P. Kirchner
Vice-President
The Carborundum Company

New Tool Alloy Speeds Machining

DEVELOPMENTS in the manufacture of metal-cutting tools have greatly speeded the war materials production program. Outstanding among these developments have been the improvements in Stellite non-ferrous tools. Following rapidly upon last year's improved "Star J-Metal" for general machining has come a new cobalt-chromium-tungsten alloy designated 98-M2, especially designed to increase the speed of machining steel.

Thorough production tests on many types of steel have already resulted in the adoption of this alloy on a large variety of parts important in the war program. The new tools machine steel at even higher cutting speeds than "Stellite", "Star J-Metal" or "2400" tools, with longer life between grinds. With them, heavy roughing cuts with coarse feeds get high rates of metal removal, yet tool life is long and economical, for the new alloy is well balanced in red hardness, edge strength, and toughness.

Consequently, tools of 98-M2 are, today, making big increases in the production of shells, aviation parts, gun parts, tank parts, armor plate, and many other items vital to the war effort. Specific operations include turning, facing, boring, reaming, milling, grooving, cutting-off, forming, spot facing, core drilling, and counter-boring.

R. L. Lerch
General Sales Manager
Haynes Stellite Co.

Manufacturing Grinding Machinery on Assembly Line

ACCURATE grinding machinery of most modern design is a prerequisite, if parts of high accuracy are to be made. To extend its production of this necessary machinery and of abrasive products Norton Company has added to its own large buildings and leased additional manufacturing space, constructed new tunnel kilns, hired hundreds of new employees and absorbed them into its skilled organization, and has adopted new production techniques, the most outstanding of which is the straight-line assembly of machine tools. In these efforts the workmen, in addition to our engineers and production men, have been prolific in valuable suggestions for conserving tools and equipment, and for improving operations. It is with pride that accomplishments along these lines have brought us first the Navy "E" for excellence, and more recently the "Star" for continued production during the intervening six months.

Associated with these advances at the machine tool factory have been consistent efforts to teach the ultimate users how best to operate precise grinding equipment. Numerous instruction booklets have been issued for apprentice grinders, as well as technical data sheets for experienced hands. Four new films have been produced and widely circulated among war plants showing correct set-up and operational hints. We have also a 6-day instruction course at the factory that has been attended by hundreds of our customers' supervisors and leadmen; thus we have been teaching the teachers.

Norton Company

Right Fluid Speeds Metal Cutting by 30%

WITH eminent technologists convinced that the intelligent application of cutting fluids alone can increase cuts, speeds and feeds of metal working, and therefore production up to 30% in many plants, the efforts of this company today are largely concentrated on the objective of getting the right cutting fluids (or deep drawing lubricants) on the right job at the right time, thereby contributing definitely to the national war effort in a degree not ordinarily realized.

Tracy B. Langdon
Vice-President
D. A. Stuart Oil Co.

Better Oils for Cutting and for quenching

AMONG the Gulf petroleum products contributing directly to the war effort are two recently developed products of particular interest in connection with the manufacture of ordnance — "Super-Quench", a new dual-action quenching oil, and "Cut-Aid", a superior cutting oil for many types of machining operations.

The new quenching oil is unique in provid-

ing a faster cooling rate for the steel through the hardening temperature range, yet it retains the slow speed of cooling that is characteristic of the conventional quenching oils below this range. As a result, improved physical properties are obtained in many types of steels, while retaining the minimum distortion of oil quenching. It is therefore possible in many instances to obtain desired physical properties in steels of lower alloy content, thus saving the scarce alloying elements.

"Cut-Aid" is a compounded cutting fluid which performs a dual function. Used alone, it is ideally suited for cutting aluminum, magnesium and non-ferrous alloys. Its second function is as an energizer for other cutting oils, regardless of type or viscosity. In both functions, it is showing outstanding results: Greater production, longer tool life, and better finishes on the work.

H. P. Hobart
General Manager
Lubricating Sales
Gulf Oil Corp.

Helping the Jobbing Machine Shop convert to rapid mass production

THE BATTLE of production is constantly being fought on many fronts, the major home-front engagement being a drive to increase machine productivity. Standard Oil Co. (Indiana), working closely with many plants engaged in solving war production problems, has reinforced the line with new cutting oils, representing the progress of a coordinated development and research program. These new products known as "Stanicut" have successfully passed the proving ground of increased production in many plants.

It is significant that several major problems must be considered in the light of present day metal working operations. First, many shops which formerly operated on a jobbing basis are now operating continuously on the same part. Now it is possible to supply such shops with the oil which gives the best results on the particular operation, rather than a compromise product to fit the miscellaneous demands of a wide range of machining operations and metals. Second, faster speeds and methods of tooling have increased the demands made on the cutting fluid. Third, there has been much wider use of alloy steels with lower machinability ratings than metals commonly encountered in the past. Added to all these conditions is the demand for close tolerances in sizes and for good finishes.

L. C. Welch
Assistant General Manager, Sales
Standard Oil Co. (Ind.)

Improved Lubricants for Severe Services

WAR MACHINERY — machinery for making war, and machines to make such machinery — operate at continually higher speeds, bearing pressures, and correspondingly higher temperatures. For lubricating such equipment, dispersions of colloidal graphite have been widely used. Many interesting and novel applications are specifically for war uses, and consequently cannot yet be written about; however an interesting number of non-secret items have resulted in the ability of Acheson's technicians to reduce the graphite particle size and to produce dispersions in oil, water, glycerine, castor oil, mineral oil and carriers not heretofore available. Typical uses include the following:

Die lubricants in drop forging, die casting, cold forging, wire drawing, punching and extruding operations.

High temperature lubricant for conveyor chains, hot metal conveyors, molds for glass, metal and plastics, trunnions for high intensity searchlights.

Lubricants for threaded fittings to prevent seizure, even though subject to excessive temperature changes, pressures, and salt water.

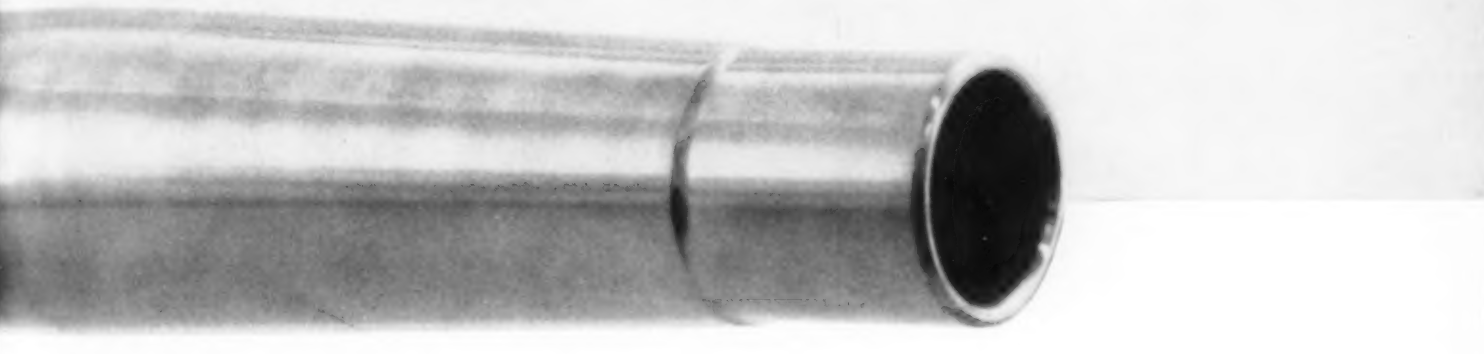
Run-in lubricants for aircraft and truck engines, machine tools, presses, compressors, pumps, and crushers.

A rubber lubricant to eliminate squeaks in pads, bushings, and insulators used throughout trucks, aircraft and machinery.

An interesting safety-first application in places where sparks of static electricity would be hazardous is the use of conductive colloidal graphite films applied to belts and other nonconductors that run at high speeds. These films aid in bleeding off static charges which are so dangerous in ordnance plants and flour mills.

John M. Lupton
Advertising Manager
Acheson Colloids Corp.

What's the most important half second in the life of a crankshaft?



YOU'RE looking at one of the sweetest pieces of precision engineering that ever stirred a craftsman's heart. Accurate as the balance wheel of your watch, this airplane engine crankshaft will soon be helping some pilot show the enemy what American men and machines can do.

However, in the split-second in which the final grinding operation on the shaft was completed, had the operator taken off just 0.001 inch more than the minimum diameter specified for the bearing, for instance, the shaft would never have seen action at all. Its value would have been reduced to scrap. And the staggering total of man and machine hours which had gone into it up to that point would have been worth absolutely nothing.

Can you find a single operation in war production where so much is at stake as in the final grinding process? Because of the key role it plays in war output, the grinding operation is one of the first places to check for ways to conserve materials, effort and time.

Make certain that your grinding machines are being operated with the utmost possible care. Make certain too that you are using the right grinding wheel for the particular job at hand. It is a *Weapon of Production* and should be properly used for maximum effectiveness.

Manufacturer's recommendations should be carefully followed on wheel speed, work speed, rate of infeed, wheel traverse, proper coolant and wheel grading (grit, grade and bond). Only the correct balance of these several factors will insure maximum production.

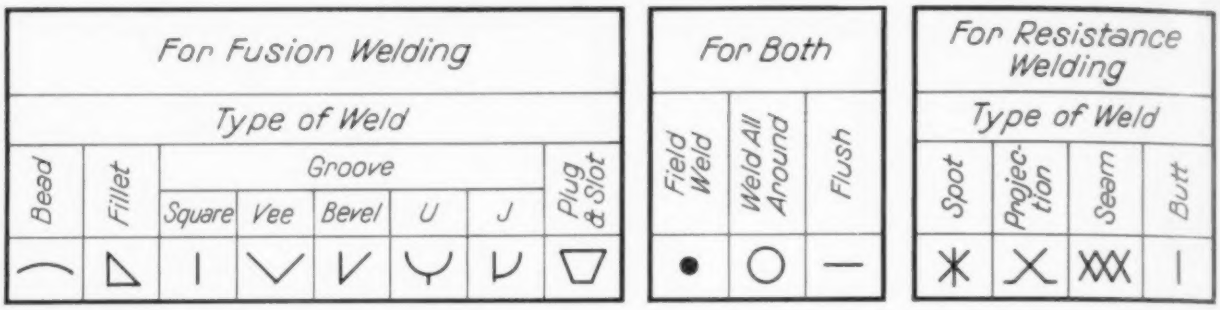
You are cordially invited to visit us at Booth C-122
National Metal Congress Exposition
Cleveland Auditorium, October 12-16.

COMPANY, NIAGARA FALLS, N. Y.

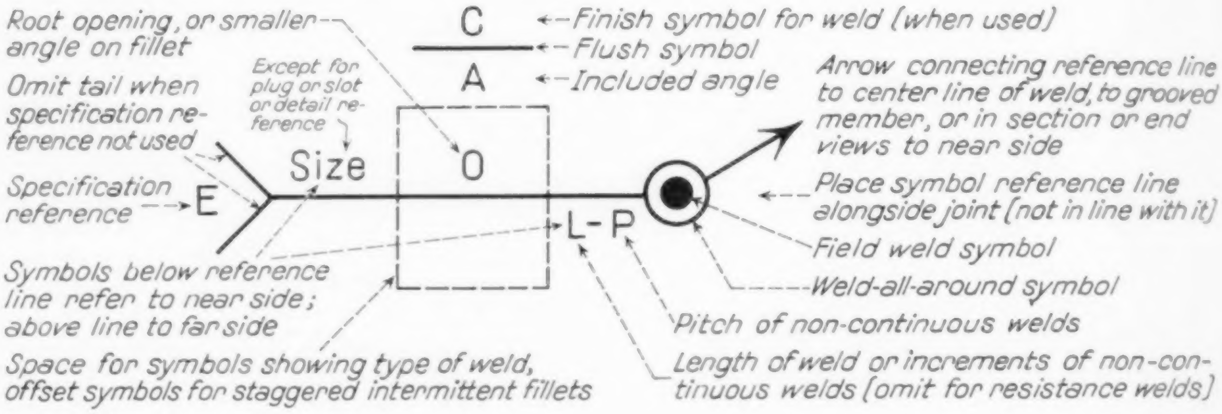
Sales Offices and Warehouses in New York, Chicago, Philadelphia, Detroit, Cleveland, Boston, Pittsburgh, Cincinnati, Grand Rapids

Welding Symbols

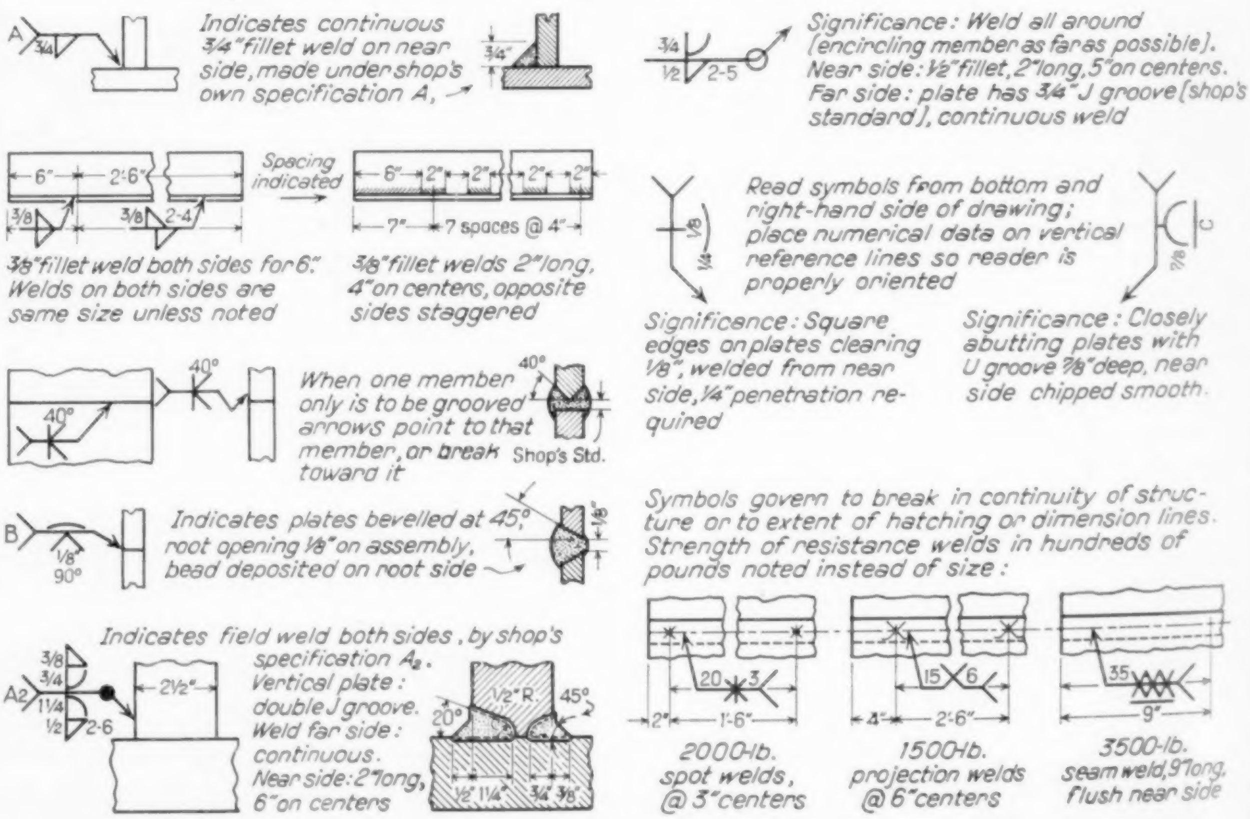
Adopted as Standard by American Welding Society, 1941



Standard Location of Information on Welding Symbols



Significance of Typical Combinations



For other combinations see "Welding Symbols," Pamphlet by American Welding Society

Toolsteels for Hot Working Iron and Steel

By H. E. Replogle, Universal-Cyclops Steel Corp.

Requirements for All Hot Work Tools:

1. Of sufficient toughness to resist working stresses.
2. Of such composition and in such heat treated condition as to resist softening when in service.
3. To have adequate wear resisting properties to assure normal, economical life.
4. Of such composition and heat treated condition as to wholly or partially resist the tendency towards heat or fire checking.

Influence of Design:

1. Wedge designs, sharp corners and thin sections promote chances of breakage and require inherently tougher compositions, usually secured through lower total alloy content steels.
2. Designs including raised sections partially or wholly buried in hot metal require types of higher red hardness and may not require as high toughness characteristics as other wedge designs.

Importance of Mechanical Set-Up:

1. All forging dies should be properly lined up.
2. Machines should be true to assure uniform application of pressure or impact.
3. Dies should be so adjusted in hand fed and automatic forging machines as to prevent excessive pressure being developed on the faces of the dies, thus decreasing probability of fatigue failures.
4. Dies should not be mounted in worn or warped shoes or holders.

Importance of Adequate Preheating:

1. Well warmed dies and tools are less susceptible to cracking.
2. Minimum temperatures secured through use of buried unit heaters in certain types of drop forging dies prolong service life and retard heat checking.

Importance of Cooling:

1. Methods of cooling—Air, Oil, Water. Retards localized heating which may exert a tempering and softening action.
   - a—Air cooling least drastic—applicable to all types of tools. Also serves to blow away scale which, if present, will cause undue wear of dies.
   - b—Oil cooling—somewhat more severe and rapid but rarely detrimental to any tool or die.
   - c—Water cooling—most effective, but very drastic and often dangerous. When large dies attain high temperatures, water cooling tends to cause heat checking. Punches and small dies are often successfully cooled with an ample flow of water.

Influence of Die and Tool Lubrication:

1. Heavy graphite bearing greases serve as lubricants and prevent sticking. Usually assures better wear.

Quenching:

Among the data given below are recommendations as to the quenching medium; oil, air and "oil & air". The words "oil & air" signify an interrupted or timed quench. With this method, a tool or die is quenched in oil to a temperature of about 1000° F., or where all color disappears. When this state is reached, the tool or die is removed and allowed to cool naturally in still air until cool enough to be handled in the bare hands. It should then be drawn as directed.

Recommended Compositions, Heat Treatments and Hardnesses

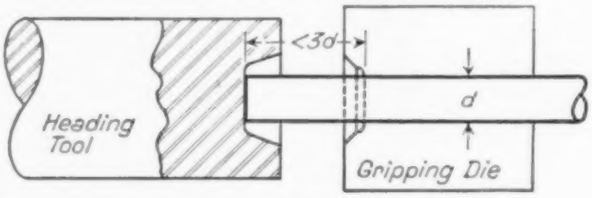
Analysis, %							Heat Treatment (°F.)				Brinell Hardness
C	Mn	Si	Cr	V	W	Mo	Pre-Heat	High Heat	Quench	Draw	
Insert Dies in Upsetters											
0.55	0.25	....	1.25	0.18	2.75	....	1400	1750	Oil	1200	400 to 450
0.30	0.40	1.00	5.00	....	1.30	1.45	1400	1850	Air	1100	400 to 450
0.30	0.30	....	3.25	0.25	9.00	....	1450	2150	Oil & Air	1200	400 to 450
0.25	0.20	....	4.00	0.50	15.00	....	1550	2350	Oil & Air	1200	400 to 450
0.40	0.60	1.50	7.50	....	7.50	....	1550	2100	Oil	1250	400 to 450
Presses, Preloaded Dies											
0.40	0.30	....	1.75	0.18	11.00	....	1550	2150	Air	1100	539 to 578
0.45	0.30	....	2.75	0.40	15.00	....	1550	2200	Air	1150	539 to 578
Gripper Dies for Hand Fed Machines											
0.55	0.25	....	1.25	0.18	2.75	....	1200	1750	Oil	1100	450 to 500
0.55	0.30	0.40	4.00	1.00	....	0.50	1200	1650	Air	800	450 to 500
0.30	0.30	....	3.25	0.25	9.00	....	1200	2150	Air	1150	450 to 500
Gripper Dies for Automatic Machines											
0.30	0.40	1.00	5.00	....	1.30	1.45	1400	1850	Air	1050	444 to 526
0.55	0.35	....	4.00	1.00	....	0.50	1200	1625	Air	1000	444 to 526
Header Dies for Hand Fed Machines											
0.55	0.25	....	1.25	0.18	2.75	....	1200	1800	Oil	1225	430 to 461
0.30	0.30	....	3.25	0.25	9.00	....	1450	2150	Air	1175	430 to 461
0.30	0.40	1.00	5.00	....	1.30	1.45	1400	1850	Air	1100	400 to 450
0.40	0.60	1.50	7.50	....	7.50	....	1550	2100	Oil	1250	400 to 450
Header Dies for Automatic Machines											
0.55	0.25	....	1.25	0.18	2.75	....	1200	1800	Oil	1250	388 to 429
0.30	0.40	1.00	5.00	....	1.30	1.45	1400	1850	Air	1100	400 to 450
0.40	0.60	1.50	7.50	....	7.50	....	1550	2100	Oil	1250	400 to 450
Forging Punches											
0.30	0.30	....	3.25	0.25	9.00	....	1500	2250	Oil & Air	1175	425 to 450
0.30	0.40	1.00	5.00	....	1.30	1.45	1400	1850	Air	1100	400 to 450
0.40	0.60	1.50	7.50	....	7.50	....	1550	2100	Oil	1250	400 to 450

The above data do not represent all of the types being used for the various applications listed, nor do they represent the only heat treatments or hardness values for these types. Neither do the above listings include flat, cut and swaging dies used in beam, steam or air hammers. However, the types and treatments listed represent the broadest general selections being used commercially today in the services noted.

Rules Governing Forging Machine Dies

(Adapted from E. R. Frost; Courtesy National Machinery Co.)

Rule I — The limiting length of unsupported stock that can be gathered or upset in one blow without injurious buckling is three diameters.

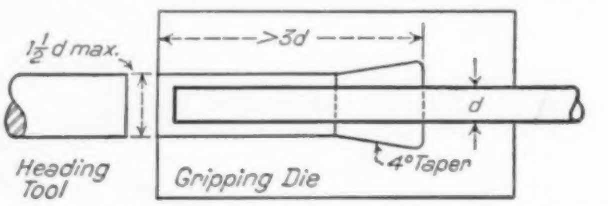


Note (*a*): A safer maximum length is $2\frac{1}{2}d$; little attention need be paid to squareness of end if $l=2d$. If $l>3d$, buckling will occur near the middle of the unsupported length. These principles hold irrespective of whether the stock overhangs the face of the gripping dies, or whether any portion is gathered in either gripping dies, heading tool or both.

Rule II — Lengths of stock more than $3d$ can be gathered or upset in one blow provided the upset is contained in either the gripping die or a straight or slightly tapered hole in the heading tool, and the diameter of the upset made in that blow is not more than $1\frac{1}{2}d$.

Note (*a*): Multiple buckling will be checked by contact with sides of the die, and friction therewith will cause a fin to form around end of upset. Such long upsets cannot be made half in one die and half in the other, for central buckle will receive no side support.

Note (*b*): A safer maximum is $1.3d$, and if Rule I is also applied, the upset will be free from end fins.



Note (*c*): For very long upsets, it is helpful to have the end of the bar at a lower temperature, and to have a minimum diameter upset for the outer half of the die, the inner half tapering 4° to wider diameter at the base.

Note (*d*): In upsetting tubing, wall thickness cannot be increased externally more than 25% at one blow; internal upsets are almost unlimited because arch effect prevents internal buckling.

Rule III — For upsets requiring more than $3d$ in length of stock, and in which the upset is $1\frac{1}{2}d$, the amount of unsupported stock beyond the face of the die must not exceed $1d$ (operation 1, at right).

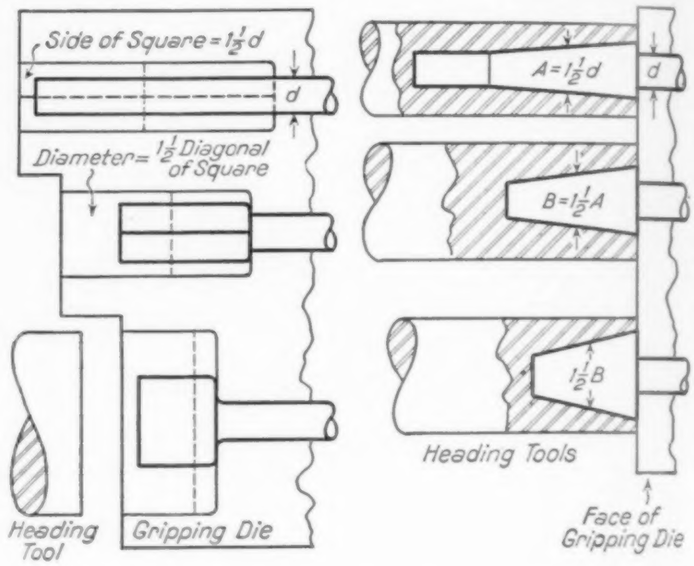
Note (*a*): Unsupported stock can amount to $1\frac{1}{2}d$ if diameter of upset is reduced to $1\frac{1}{4}d$.

Rule IV — Large amounts of stock can be gathered by multiple application of Rule II and III, and by using square or tapered impressions.

Note (*a*): In making the wide flange in sketch at left, below, the first and second impressions are within the $1\frac{1}{2}d$ limit, but the third, being a short upset under Rule I, is unlimited in diameter.

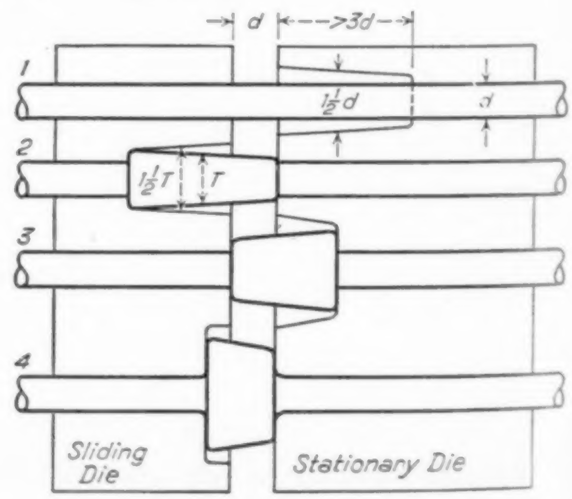
Note (*b*): The side of the square may be $1\frac{1}{2}d$ of the original bar, and the diameter of the next round may be $1\frac{1}{2}$ times the diagonal of the square.

Note (*c*): Tapered holes are proportioned as to their diameters at midlength of unsupported stock.



Rule V — Sliding dies, for upsetting stock at some distance from the end of a bar, are governed by all the above rules.

Note (*a*): Friction along the sides of the sliding die will favor upsetting near its front end, so multiple impressions should be alternately in front and rear half, or alternately in sliding die and gripping die, as shown in sketch below.



Fluxes for Oxy-Acetylene Welding & Brazing

By Houston E. Landis, Jr., and F. C. Saacke

Apparatus Research & Development Dept., Air Reduction Sales Co., Jersey City, N. J.

General Flux Characteristics

Phase — Best applied to welding rod as a paste (suspension of powdered salts in water or alcohol). Sometimes applied as a dry powder or injected as a vapor into the welding atmosphere.

Melting Point — Below temperature where an appreciable amount of oxide forms on base metal.

Film — Uniform, quiescent, transparent.

Density — Light and easily floated; no tendency to be trapped in weld metal.

Viscosity at Welding Temperatures — Should be sufficient to keep the weld metal covered and protected from gas absorption and oxidation, but not so viscous as to prevent ready fusion of the welding rod and weld metal.

Oxide Solvent — Should readily dissolve base metal oxides as well as weld metal oxides and keep contact surfaces clean at welding temperatures. (Base metal should practically always be cleaned before welding.)

Weld Appearance — All the above characteristics should combine to permit the rapid deposition of a weld free from oxides, flux inclusions, or gas pockets with smooth, clean surfaces free from overlaps or pits.

Oxy-Acetylene Welding Procedures

Base Metal	Fusion Welding			Brazing		
	Filler Metal	Flame (a)	Flux	Filler Metal	Flame (a)	Flux
Lead	Same as base metal	N	None	...	...	...
Aluminum (soft)	Same as base metal	SR to N	Type A	Aluminum solder	N or R	None
Aluminum alloy (wrt.)	Same as base metal	SR to N	Type A	Aluminum solder	N or R	None
	Silicon-aluminum alloy	SR to N	Type A	...	...	...
Cast aluminum	Silicon-aluminum alloy	SR to N	Type B	...	...	...
Yellow brass	Similar to base metal	O	Type C	Silver alloy or phos-copper	SR to N	Type H
Red or leaded brass	High zinc brass *(b)*	N	Type C	Silver alloy or phos-copper	SR to N	Type H
Silicon bronze	Similar to base metal	N to SO	Type C	High zinc brass *(b)*	N to SO	Type C
				Silver alloy or phos-copper	SR to N	Type H
Copper	Deoxidized copper	N	None	High zinc brass *(b)*	N to SO	Type C
				Silver alloy or phos-copper	SR to N	Type H
Nickel	Same as base metal	R	None	Silver alloy	SR to N	Type H
Nickel-copper alloy	Same as base metal	N to SR	Type C	Silver alloy	SR to N	Type H
	Silicon-monel	N to SR	None			
Cast iron	Similar to base metal	N	Type F	High zinc brass *(b)*	N to SO	Type E
Malleable iron	White cast iron *(c)*	N to R	Type F	High zinc brass *(b)*	N to SO	Type C
Galvanized iron	...	..	..	High zinc brass *(b)*	N to SO	Type C
Carbon steel	Low carbon steel	N	None	High zinc brass *(b)*	N to SO	Type C or D
	Low alloy steel	SR	None	Silver alloy	SR to N	Type H
Alloy steel	Similar to base metal	SR	None	Silver alloy	SR to N	Type H
Stainless iron & steel	Similar to base metal *(d)*	N	Type G	Silver alloy	SR to N	Type H
High manganese steel	Similar to base metal	N to SR	None	...	...	...

(a)
N—Neutral
O—Oxidizing
R—Reducing
SR—Slightly reducing
SO—Slightly oxidizing

(b) High zinc (38 to 44%) brass with additions of alloying elements such as tin, iron, manganese, silicon, nickel.

(c) Fusion welding of malleable iron should be followed by re-malleableizing heat treatment.

(d) 18-8 stainless steels often alloyed and "stabilized" with columbium, titanium, molybdenum, tungsten.

Specific Flux Characteristics

Aluminum Rod

Type A — An aluminum welding flux composed generally of alkali halides; characterized chiefly by the speed with which solid welds in sheet metal may be made with smooth fusion at the root of the weld and without pitting or discoloration on the surface.

Type B — A modified aluminum welding flux with additions of higher melting point constituents like borates and other chemicals to provide greater slagging action as well as additional viscosity, resistance to oxidation, and protection while making repairs in cast aluminum parts by puddle welding.

Bronze Rod

Type C — An "oxidizing" flux ordinarily made with a boric acid base. It should form a thin but strong oxide film on the surface of the molten copper alloy, thereby preventing gas absorption and excessive oxidation. Recommended for clean or cleaned iron and steel surfaces.

Type D — Where oxidized, rusty, or dirty surfaces are to be joined, an "oxide solvent" flux ordinarily made with a borax base and having a high solvent action for metallic oxides is recommended. It should keep both the base metal and the molten puddle clean and bright. (Note: This flux will not give as good weld metal characteristics as the Type C flux applied to clean surfaces.)

Type E — A "highly oxidizing" brazing flux designed specifically for removing carbon or graphite from the surfaces of cast iron. Usually contains an oxidizing component such as manganese dioxide. (Note: This flux often used with the Type C flux to provide the proper tinning action.)

Cast Iron Rod

Type F — Ordinarily made with a borax base and containing alkali salts to aid in fluxing the slag that forms on cast iron. Should permit ready fusion of the welding rod and base metal without leaving gas pockets or inclusions.

Stainless Steel Rod

Type G — A stainless steel welding flux designed to permit complete fusion at the root of a weld without burning. The best test for a flux of this type is to coat the root of a butt joint with the paste and then observe the penetration at the root after making the weld.

Silver Brazing Alloy

Type H — A silver "soldering" flux made from an alkali bi-fluoride and borax or boric acid; gives the best results on both non-ferrous and ferrous alloys, including stainless.

Metal Cleaning and Finishing

Conserves Copper, Tin and Lead

TO AID in important metals conservation, the electroplating division of E. I. du Pont de Nemours & Co. recently has developed a new method of de-plating copper. Formerly, the removal of copper plate not only was costly, but most of the copper was wasted. Today, by this new practical method, virtually all of the de-plated copper can be recovered in a form satisfactory for direct re-use as anode material. The operation is carried out rapidly under controlled conditions; up to 0.001 in. of copper can be removed in 9 to 10 min. using current densities up to 60 amperes per sq.ft. De-plating takes place without attacking the base metal — in decided contrast to usual stripping methods. Since many products are fabricated from copper-coated strip steels, the resulting scrap is a perforated web, useless until the copper has been removed. Another application of this process is its use for removing copper placed on steel parts prior to selective casehardening.

The new "Halogen Tin Process" for the tin plating of strip steel allows lighter coatings of tin, which are satisfactory for many purposes. Much less tin is used than in hot-dip tinning methods.

Recently developed by the Du Pont Co. also is a new lead plating process — "Sulfamate Lead" — which is a very practical method for applying smooth coatings of lead to metal articles, not only suitable for the usual protective coatings, but also for parts which must resist highly corrosive conditions and for those uses which do not require the decorative qualities of a bright finish.

E. I. du Pont de Nemours & Co.

Intense Production of Fundamental Chemicals

THE CONTRIBUTION of American Cyanamid Co. and its subsidiaries to the war effort has been substantial. As raw material producers their products enter into almost every phase of our nation's activity. Aggressively in many cases, abruptly in others, our operations have been diverted to war production and essential civilian uses.

As engineers and builders of chemical plants, Chemical Construction Corp., a subsidiary, has designed or erected over 130 plants for the United States and the other United Nations and for private contractors. In the field of medicine the Cyanamid group has been a leader in the production of sulfonamides, sera, vaccines and surgical sutures. The war uses of our plastics, particularly the newly developed "Melmac" for aeroplane and other military and naval uses has increased to the absorption of a large percentage of the output.

Practically all compounds — and they are very numerous — produced from calcium cyanamid are now on complete allocation. These products include chemicals required by the agricultural fertilizer industry, the dyestuff and dry color industry, the explosive industry, the glass and leather industry, oil refining, paints and varnishes, paper and textile industry, synthetic rubber, water purification, as well as metallurgical, metal producing and finishing industries.

Most of Cyanamid's products are basic in nature and few have been changed in formula or process by the war. There has been a diversion in use rather than converting plants to

make different materials. The chemical picture is never complete and the research work of Cyanamid is even more important in wartime than in peacetime.

To give a complete picture of any great chemical company's activities would require volumes. One example of particular interest to the metal trades in which Cyanamid's research has contributed to the war efforts is the development of a liquid carburizing process which widens the use of existing heat treating equipment. This new process can produce case depth in liquid baths up to 0.15 in. and produce a hardness of Rockwell C-67 on S.A.E. 1020 steel (carburized at 1750° F., reheated to 1440° F. and quenched in water).

The energies of all our people are today centered on victory. Fortunately for mankind in the present crisis, the progress which is being made will not only help achieve that victory but will be a real contribution to our future civilization.

R. H. Landis
American Cyanamid & Chemical Corp.

Stripped Units Get Production Going
accessories mounted later

FOREMOST in our program to meet the constantly expanding and changing requirements of the war effort is the development of new and different handling methods and conveyor mechanisms in degreasing and washing equipment to ready the work for close tolerances and to meet critical inspection. While the methods and machines were designed primarily for the processing of war goods, foresight in the design envisions the same machines in post-war industry. "Detrex" cleaning machines and chemicals are helping make such vital items as bombers, fighter aircraft, bomb sights, engines, air frames, flying instruments and wheel assemblies. Other items include bombs, shells, cartridge cases and clips, boosters and fuses, in addition to machine guns, rifles, small cannon, anti-aircraft guns, tanks and tank parts, blitz buggies and trucks. There are also field radios and field communication systems, and medical and hospital equipment.

This company has developed a full line of spray booths and washers using emulsion cleaners and petroleum spirits for cleaning aircraft engines.

The armament section of war production has been served through the development of a machine for the thermal shock testing of projectiles, a machine and process which shows up any flaws in the shell — thus contributing to both production and firing efficiency.

To keep production rolling, despite its contribution of many men to the army forces, we increased our staff of field service engineers by 50%. This was done to make available to new war plants the required information on metal cleaning. Despite the manpower shortage, Detroit Rex Products Co. is constantly adding and training new workmen to its payrolls who are being apprenticed to experienced technicians already in the plant.

One single instance of how this works to save a manufacturer's time and get an earlier production start: We shipped a degreaser with certain accessories missing, later to be assembled on the spot. This gave us time to obtain a "hard to get" part, while our client utilized the advanced delivery date to get the machine properly located. The procedure is practical only because our field engineers are thoroughly trained in this type of work.

W. W. Davidson
Vice-President in Charge of Sales
Detroit Rex Products Co.

Power Brushing Replaces Hand Finishing Methods

DURING the last 18 months, this company has developed more than 100 kinds of brushes for war use. Some new applications have resulted in efficiency increases as great as 1000%. This actual gain was reported by one aircraft manufacturer who had us design a brush to remove a zinc chromate coating from around rivet holes. This was to assure a suitable surface for bonding; cleaning had previously been done by hand and sandpaper.

Brushes were developed for shipbuilders to remove scale that collects on steel sheets and plates. The many welds that go into the construction of ships, tanks and other war machines must also be brushed free of slag. Osborn brushes have speeded up some of these opera-

tions as much as 100%, one shipbuilder reported.

The importance of power driven brushes in the war effort may be appreciated when it is known that nearly 20 different brushes are used on an airplane engine before it is completed.

Both the sizes and materials of industrial brushes vary over a wide range. Some are made from steel, brass or aluminum wire, ranging from 0.0025 to 0.090 gage. Some are made from cotton cord, from Tampico fiber taken from a century-plant grown in Mexico, some from hog bristles normally imported from China and the Soviet Union. One of our newest for removing rough edges from bomb sights is made of nylon fiber 0.002 in. diameter.

For retreading tires, Osborn engineers have developed a special brush with needlepoint wires. The sharp points, in contact with the tire, produce a highly adhesive surface.

As the oil and gasoline stringency placed higher demands upon pipelines, our engineers devised a unique brush that is impelled by compressed air through the pipe at a rate of 4 to 5 mi. per hr., pushing the sludge before it. This "brush" is a series of disks on a flanged cylinder with metal spacers between them.

G. O. Rowland
Brush Division
Osborn Manufacturing Co.

Metal Cleaners Eliminate Production Bottlenecks

DETERGENT manufacture has not changed markedly in the last year, yet this company is contributing to increased output of war products by increasing the speed of metal cleaning throughout the metal working industry. Production bottlenecks are being eliminated by the use of our anhydrous alkaline metal cleaners and solvent emulsion-type cleaner, as well as our detergent silicates. Cowles Detergent Co. also renders technical service in the plants, through a staff of technical service men. We are proud of our record to date and the list of fine companies which we are serving and the history of our work in their plants.

E. F. Clark
Manager, Metal Cleaner Dept.
Cowles Detergent Co.

Technical Help for Plants Newly Producing War Materials

WE ARE FINDING that wartime developments in specialized metal cleaners and degreasing compounds consist not so much in making fundamentally new products as in producing the old ones in unheard-of amounts and in teaching many new men how to use them to best advantage — men in plants now converted to munitions.

Different set-ups of cleaning equipment require the use of different metal cleaning products. Wherever brass and steel cartridge cases, armor piercing and high explosive projectiles, bomb fins, bomb cases, fuses, gun parts, airplane and tank motor parts, steel helmets, and scores of other metal parts necessary for victory are being cleaned, you will find "Wyandotte" metal cleaners and our technical men. We are proud of our record of promptly supplying both written and personal technical assistance on cleaning operations to the management of plants newly engaging in war production. "Getting the bugs" out of cleaning operations frequently eliminates a bottle-neck.

Our technical men in wartimes are dealing with the same types of metal cleaning operations that they have encountered in peace times. The end product has changed, but the basic problem is the same — that of providing chemically clean metal surfaces for further processing without delaying or upsetting production. Problems presented to them and solved by them include cleaning after drawing and machining, cleaning prior to painting or lacquering, cleaning before and after heat treating, cleaning prior to cadmium or hard chromium plating, and cleaning prior to anodizing or spot welding.

W. M. Cole
The J. B. Ford Sales Co.

Ferric Sulphate for Cleaning Cartridge Brass

WHEN the present emergency arose, Monsanto Chemical Co., like a number of other manufacturers, was able to and did turn many of its important peacetime developments directly into the war effort. Of those affecting the metallurgical industry, probably three are outstanding:

An entirely new plant for the manufacture of phosphoric acid and phosphates used in the pickling, cleaning and rust proofing of metals was completed and placed in operation in Michigan. This plant greatly increases the company's former output of these chemicals and is a further outgrowth of our electric furnace phosphorus program started in 1937 with the construction of the world's largest elemental phosphorus plant.

Ferric sulphate, for which Monsanto built the first large-scale plant in the country a little over five years ago, is now showing outstanding advantages in the pickling of copper, copper alloys and stainless steel. Scale and black and red oxide stains have given much trouble in drawing brass cartridge cases, and ferric sulphate-sulphuric acid baths are cutting down both the time to remove them and the metal losses.

The majority of the output of a new sulphuric acid plant completed last year is being used in the production of aluminum.

In addition to these major contributions a number of less spectacular refinements have been accomplished in these and other of our products serving the metallurgical industry.

FRANCIS J. CURTIS
Development Director
Monsanto Chemical Co.

Automatic Equipment for De-Scaling Shells, Inside and Out

BEGINNING with the Lend-Lease Armament Program, machinery manufacturers, as well as iron and steel producers, called for tremendous increases in manufacturing equipment including blast cleaning and dust control installations. Pangborn's problem was to triple the production of its standard machines, and at the same time design, develop and install special handling equipment for cleaning and removing surface scale from shells, bombs, tanks, armor plate, airplane motors, and fuselage parts. These demands were promptly met. Enlargement of plant facilities, three-shift, 24-hr. operations, sub-contracting of machine and plate work, training of new supervisory forces and help, and combined teamwork of management and employees have brought the desired results.

An outstanding achievement has been accomplished in descaling the interior cavity of shells, 75, 105, and 155-mm. caliber. A single purpose machine was developed for this work, which, by change of fixtures, will handle any of the sizes.

Another Pangborn accomplishment has been the large combination air and airless cabinet for descaling the interior and exterior surfaces of aerial bombs, ranging in size from 250 to 2000 lb. This machine is entirely automatic and cleans both surfaces simultaneously.

When the demand came for cleaning the exterior surfaces of airplane cylinders, preparatory to metal coating, our engineers developed a special machine which produced 75% more work than had been expected.

Variable pitch propeller blades for large airplane engines presented another blast cleaning problem. Heat treatment of these blades produced scale — but equipment was quickly perfected to remove this scale without damage to the delicate surface.

Armor plate required very large and strong equipment to handle pieces up 40 ft. long and from 1½ to 2 in. thick. Pangborn blast machines are now cleaning great quantities for ships and tanks and planes.

The well developed cloth screen filter for dust control has also fitted into the war program by salvaging valuable dust that otherwise would be lost to the process industries. Other collectors also improve working conditions in plants the country over.

P. J. POTTER
Executive Vice-President
Pangborn Corp.

Carbon and Synthetics Replace Scarce Nickel and Rubber

PROCESSING machinery and equipment so necessary to the war effort has been manufactured at an exceptionally high pace, in order that the munition makers can meet the quotas established. It has been our privilege to furnish a great deal of this equipment for surface treatment, plating and cleaning. Certain processes have been greatly emphasized, such as the cleaning and anodizing of aluminum and magnesium

for aircraft work. Much larger tank units have been necessary, engineered to operate in air conditioned buildings. Fume removal hoods on the tanks have been arranged to exhaust below floor level, permitting free crane space above, in the third dimension.

Glass is now being used in these anodizing tanks to prevent undesirable electrical effects on the expensively machined aluminum products being treated. In the newer acid cleaners used for aluminum parts, we have adapted synthetic rubber tank linings and our "Nocorodal" carbon coils for heating. These eliminate smudged work caused by the presence of other metals, particularly lead coils and lead linings. In order to replace rubber as a chemical tank lining material in pickling and plating operations with a less critical material, we have adapted a thermoplastic and another synthetic rubber-like material.

"Nocorodal" coils, jets and other heating devices, made of impregnated graphitic carbon, are replacing critical monel, nickel, copper, and stainless steel piping used in chemical baths. Steam jets have also been doing an excellent job, combining the heating and agitating of sulphuric pickles, otherwise requiring critical machinery. On the whole, the war effort has necessitated at least a 50% change-over in the type of equipment which we normally would be manufacturing for the metal finishing industries.

Carl E. Heil
Heil Engineering Co.

Cuts Polishing Time 20%

SHORTAGES of materials have struck hard at some essential industries using imported items other than much-publicized tin or rubber. Small solid polishing wheels or bobs of superior quality have long been made of walrus leather—now no longer obtainable. Advance Polishing Wheels, Inc., has been able to develop a sheepskin bob and a soft "bullneck leather" bob which have been found quite suitable for numerous uses. Other new polishing wheels have been devised for cutting polishing time. Our canvas cup wheel, in particular, has reduced the time of finishing master connecting rods for bomber engines by at least one-fifth.

Our associated Matchless Metal Polish Co. has also produced a greaseless composition for faster and cleaner burring of steel and aluminum parts, whose use has saved as much as one-quarter the time previously required. This self-setting compound is applied by hand to the face of revolving muslin, leather or canvas buffs or bobs, and can be used immediately, thus eliminating much of the time lost in setting up fine grain polishing wheels. Because of its flexibility and fast cutting it removes small burrs in a fraction of the time required for hand filing, emery papering or de-burring with cutting tools. It has the further advantage of not feathering the edge of the metal—as is often done when harsh sanding belts are employed for this purpose.

James J. Manderscheid
President
Advance Polishing Wheels, Inc.

Improves Bearings and Solders

JUSTIFIABLE pride may be taken in the fact that, due to years of research and development, indium metal has been brought into industrial prominence, since it is able to contribute valued qualities needed in many of the defense problems.

The early work on indium as it relates to bearing materials, done by C. F. Smart of the Pontiac Motor Co., had acquainted the automotive and airplane engine manufacturers with the possibilities. To date, where engines have to earn their own way, the additional cost of treating bearings with indium is more than justified. Undoubtedly, when automobile production is again resumed, better bearings will be demanded. Looking to the future, automobile manufacturers are now experimenting with ways and means to meet this requirement. Fortunately, a very thin coating of indium protects the bearing against the corrosive action of hot oils containing acids, and experiments show that they last twice as long as untreated bearings. They have completely solved engine bearing trouble in heavy-duty engines used in defense machinery.

Another important application is in solders. Indium increases the wetting and spreading qualities of brazing and solder materials. Due to its low melting point, it is a constituent of brazing materials low enough in melting point

so that they may be used on hardened steel without affecting the temper — a real step forward in getting an easy-flowing brazing material with plenty of strength and resistance to shock. Solder, developed by The Indium Corp. of America, containing no tin, has a melting point below 600° F. Another characteristic of indium is its high boiling point (low vapor pressure) so it does not give off vapors which would be objectionable when exposed to high vacuums.

In these two ways has this corporation been able to contribute a share in the conservation of vital materials and the development of superior wearing surfaces for moving parts.

M. T. Ludwick
Assistant to the President
Indium Corp. of America

Protective Coating Replaces Strategic Metals

As America's war industry grew, so grew a demand for a suitable protective finish for steel items that would answer the engineering specifications without the use of strategic metals for electroplate or dip coatings. The penetrating black finish perfected by Heatbath Corp. furnished a happy solution, thus releasing quantities of metals for other important purposes. A "War Service Department" was established to work with numerous Government agencies on educational data, equipment specifications, laboratory tests and similar work, thus offering a central agency to expedite emergency defense and solve production problems. The heavy demand was double-barreled in that manufacturers of articles for civilian consumption were also forced to seek a substitute for metallic finishes. To meet this additional demand, sales representatives were trained as demonstrators, and the factory demonstration personnel was increased in order to render prompt and efficient technical service throughout the entire country and in Canada. Automatic concentration control and conveyor equipment has been worked out to match the production lines of larger war plants. In our own factory a continued expansion program is in progress and the working shifts have been staggered to effect an ever-increasing flow of material.

Fowler W. Wilbur
Vice-President
Heatbath Corporation

Removes Scale but no Metal

With the tremendous increase in steel forging, process annealing, normalizing and other heat treatments, the amount of cleaning and de-scaling that must be done has correspondingly increased. The Bullard-Dunn process — an early version of which was described in one of the first few issues of Metal Progress — is speeding production of war products by cleaning scale and oxide from such work as airplane engine parts, machine gun parts and bullet dies which require complete removal from every surface — including the recesses — without any attack at all on the basis metal. After this treatment, the work is free from any abrasive material as well as oxide, for no abrasives have been used.

In fact the steel is so chemically clean that it is in perfect condition for final assembly, finish grinding, or the application of electroplates or chemical coatings that give the best possible resistance to corrosion. Production is accelerated because it reduces over-all cleaning time, and because it cleans so well that subsequent operations are expedited. Simplicity of operation contributes to its usefulness at this time because it can be operated by unskilled labor and individuals who are not needed for the various Services.

Since many parts can be treated at one time, work handling in a station type conveyor is economical. This is a rotary, hydraulically operated machine, used very successfully for the Bullard-Dunn process and other jobs involving heavy loads and high lifts. The machine is automatically timed. To speed the handling and cleaning of small parts, a barrel and rotating mechanism can be added to the machine. There are two types of these conveyors, single timed and dual timed. The single-timed machine leaves the work in each treatment for the same length of time. The dual-timed machine will convey work through an alternately timed sequence such as 2 min., ½ min., 2 min., ½ min., and so forth, a sequence which is especially useful for cleaning prior to plating where the rinses should be of short duration.

Thomas H. Wilber
General Manager
Bullard-Dunn Process Division
The Bullard Co.